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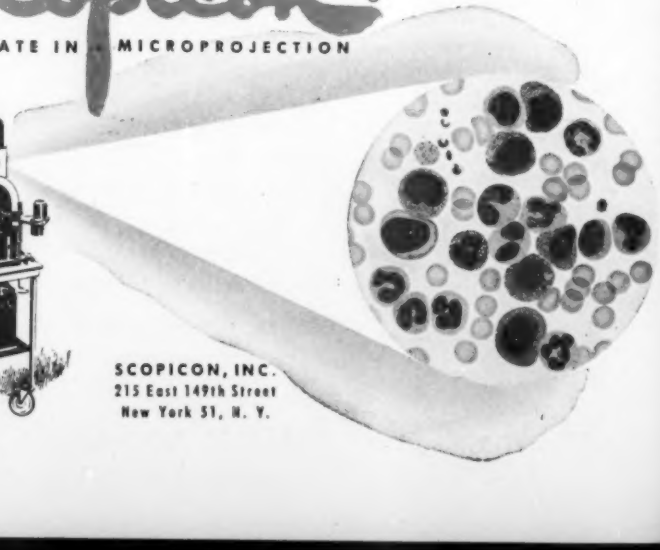

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On the Averaging of Data

S. S. Stevens

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AS every scientist knows, the problem of how best to average a set of data is not always easy to solve. First of all, we have a choice among the conventional measures of "central tendency" or "location," such as the mode, median, arithmetic mean, geometric mean, or harmonic mean. Each of these measures has its uses and its restrictions, but the problem is sometimes more complicated than the simple choice of one of these statistics. Complications are especially likely to arise when the quantity we want to average is a nonlinear function of the readings obtained with a particular instrument or indicator. Under these circumstances the distribution of the indicator readings is skewed relative to the distribution of the values we are interested in, and the problem becomes how to undo this skewness and the bias it produces.

Two possible procedures are available: (i) we can eliminate the skewness by making an appropriate transformation of the data, or (ii) we can bypass the problem of skewness by using a measure, such as the median or the mode, that is invariant under nonlinear monotonic transformations of the scale values. But these alternative procedures are not open to us unconditionally, for it matters considerably on what type of scale the measurements are made. Let us first examine the relationship between the various kinds of scales of measurement and the several measures of central tendency, and then let us consider an example of how we might proceed to rectify the bias in the arithmetic mean when this bias results from the use of an arbitrary measure that is nonlinearly related to the variable we are concerned with.

Scales and their statistics. The kinds of scales on which we measure things can be divided into four classes: *nominal, ordinal, interval,* and *ratio* (*1*). To each of these types of scales certain statistics are appropriate and others are not. Hence it is a matter of first importance to know which kind of scale we are dealing with. The kind of scale we work with depends, of course, upon the concrete empirical operations we are able to perform, and, as we might expect, the character of the operations determines the kind of statistics that are permissible.

This comes about because a scale erected by a given set of operations can be transformed in certain permissible ways without doing violence to the essential nature of the scale. As a matter of fact, the best way to specify the nature of a scale is in terms of its "group structure"—the group of mathematical transformations that leave the scale form invariant. And it follows quite naturally that the statistics applicable to a given scale are those that remain appropriately invariant under the transformation permitted by the scale.

This is a simple but powerful principle. It applies to all the kinds of statistics we use in the treatment of experimental data, but since we are in this article (*2*) concerned only with the statistics of central tendency we can summarize the relations between these statistics and the four kinds of scales by means of Table 1. It should be noted that the last column of the table is cumulative in the sense that a given statistic can be used with the scale indicated, as well as with all the scales listed in the rows below. The list of empirical operations in the second column is likewise cumulative, in the sense that in order to set up a given scale we need all the operations in the second column down to and including the operation listed opposite the scale.

Table 1 shows that the mode is the most general measure of central tendency. It is the only one of these statistics that may properly be used with a nominal scale, but it is a measure that may be used with all other types of scales as well. The nominal scale is the most general, or, if you like, the most

Table 1. Each of the four kinds of scales (column 1) rests on a set of empirical operations (column 2). Each scale remains invariant under certain mathematical transformations (column 3), and admits of certain measures of central tendency (column 4).

Scale	Empirical operations	Permissible transformations	Permissible measures of central tendency
Nominal	Determination of equality	Any one-to-one substitution	Mode
Ordinal	Determination of greater or less	Any increasing monotonic transform	Median
Interval	Determination of the equality of intervals or of differences	Multiplication by and addition of a constant	Arithmetic mean
Ratio	Determinations of the equality of ratios	Multiplication by a constant	Geometric mean Harmonic mean

primitive type of scale. The scale values are used only as identification tags for types or classes, such as model numbers, and with nominal scales the mode can be used to indicate which type or class has the most members in it.

The median can be used as a measure of central tendency only if the scale rests at least on an ordering operation that permits us to establish a rank order among the items measured. The classic example of an ordinal scale is the scale of hardness, where the rank order is established by the determination of what mineral will scratch what other minerals. The median may be used with ordinal scales such as hardness, and also with interval and ratio scales. As a matter of fact, the slight loss in statistical "efficiency" that results from computing the median instead of the arithmetic mean is often more than made up by the fact that the median is relatively insensitive to skewness. It is probably fair to say that the median is exploited much less than it ought to be.

Strictly speaking, the arithmetic mean is not a proper statistic for an ordinal scale, although it is often used in averaging such ordinal values as scores on tests and grades in courses. Only when we possess some operation for assuring the equality of intervals is the arithmetic mean appropriate. The classic examples of interval scales are the scales of temperature, Fahrenheit and Celsius. When we use these scales it is proper to speak of mean temperatures—as well as median or modal temperatures. The interval scale has equal units, but its zero point is arbitrary. Hence on an interval scale the computation of a geometric mean or a harmonic mean makes no sense. These two statistics are reserved exclusively for ratio scales on which the zero point is fixed. Examples of ratio scales are the everyday scales of length, weight, volume, and so forth. With ratio scales, all measures of central tendency are in principle appropriate, and which measure we decide to use must be dictated by our purpose.

The geometric mean and the harmonic mean can sometimes be used to correct the skewness in a set of data. Since these measures effect a transformation of the data, they are good for special cases that may arise in practice. The geometric mean is appropriate when the quantity we are interested in is proportional to the logarithm of the indicator reading, and the harmonic mean is appropriate when the relation is a reciprocal one.

Situations often arise, however, in which the required function is neither logarithmic nor reciprocal. The relation may in fact be such that no simple mathematical function can express it. How then do we proceed?

An experimental example. The question of how we might average indicator readings when these readings are nonlinearly related to the quantity we are trying to measure arose in an experiment on loudness. A group of 45 subjects undertook the relatively simple task of dividing a range of loudness into four equal-appearing intervals. The top end of the range was the loudness produced by a 1000-cy/sec tone about 90 db above threshold. The bottom end of the range was 40 db lower.

The subject produced the individual loudnesses by pressing one or another of five keys. Above each of the three middle keys there was a dial by means of which the subject could adjust the loudness. His task was to adjust each of the three dials until the loudness intervals between the successive tones all sounded equal to one another. He was required to test the apparent equality of the intervals by listening in both the ascending and descending order. Each subject repeated the experiment three times.

The results were recorded with the aid of a vacuum-tube voltmeter connected across the earphones. Since this was a logarithmic voltmeter, it was convenient to record the subject's settings in decibels relative to an arbitrary standard. Then with the data recorded in decibels, the question arose how to average them.

The common procedure in such instances is simply to compute the arithmetic mean of the readings as they are recorded. Second thought suggests, however, that the subjects were not listening to the logarithm of the voltage across their earphones. Rather they were listening to loudness, and their performance was in terms of the loudness heard. Since they were dividing a range into equal intervals, we can assume that the loudness they were dividing is measurable on at least an interval scale. If this is true, we are justified in taking arithmetic means of the loudness values, but, of course, we do not start with loudness values—we start with decibel readings.

It appears that the problem can be solved by an iterative process involving successive approximations. We can average the decibel values to obtain a first approximation of the relation between decibels and loudness. Then, using this approximation we can convert from decibel to loudness values and proceed to average the loudness values. This average provides a closer approximation to the relationship we seek, and using this closer approximation, we can repeat the process to determine the relationship to a still closer approximation. In this way we can make the approximation as close as we desire.

Concretely, the arithmetic means of the decibel readings were first determined and plotted (small circles in Fig. 1). The end points of the loudness range (plotted vertically) are arbitrarily called zero and 100, and the values 25, 50, and 75 mark off the equal-appearing intervals as set by the subjects. We see that over this range the subjective loudness is not a linear function of decibels. Next we draw a smooth curve (solid line) through the circles, and with the aid of this curve we change each of the original decibel readings into a corresponding loudness value. Then we average these loudness values and proceed, again via the curve in Fig. 1, to find the decibel readings that correspond to the averages of the loudness values. These new decibel readings can next be plotted in Fig. 1 to determine a new curve, the dashed curve. The process can then be repeated to determine a still better

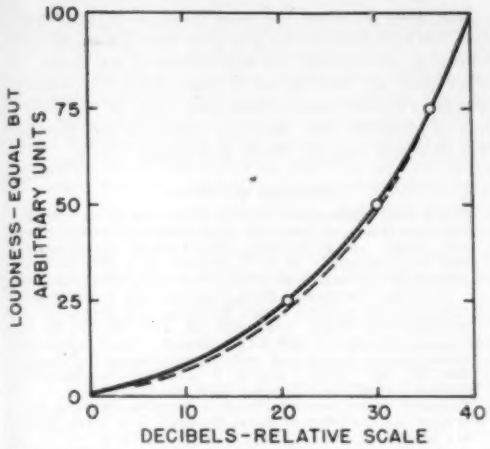

Fig. 1. Forty-five subjects adjusted three attenuators in order to divide a 40-db intensity range (abscissa) into four equal-appearing loudness intervals (ordinate). The circles, showing the arithmetic means of the decibel settings, provide a first approximation to the relation between loudness and decibels. The dashed curve shows the better approximation obtained by averaging the loudness values that were determined from the solid curve.

curve than the dashed curve, but in this particular example the new curve would be almost indistinguishable from the dashed curve.

The successive functions obtained by this procedure have greater and greater curvature, relative to that of the function determined by the original averaging of the decibel readings. The degree of the change in curvature depends on the variability of the data. If variability were nonexistent, the curvature of the function would not be changed by this process.

What we are assuming here is that it is more sensible to average loudness than to average decibels. As a further test of the reasonableness of this assumption, let us examine the forms of the distributions of the subjects' settings. Since the subject's task was to divide a fixed interval into four equal sections, it is reasonable to assume that, when measured in the proper units, the errors would distribute fairly normally, and that the greatest variability would attach to the setting that divides the total range in half—the midpoint on the ordinate of Fig. 1. We can also expect that the variability of the settings for the points 25 and 75 would be about the same size.

When we average the decibel readings, these expectations are not borne out. As shown in the upper part of Fig. 2, the histogram is broadest for the 25 point and narrowest for the 75 point. On the other hand, when we average the loudness values the distributions turn out as expected. As is shown by the bottom row of histograms in Fig. 2, the variability is greatest for the settings made to the midpoint of the loudness interval.

The experiment described here has been repeated at several intensity levels and similar results have been obtained. It has been possible to pool the data for 49 subjects who made a total of 405 settings at each of the three quarter-section points. The loudness values were averaged and the standard deviation computed and expressed as a percentage of the range of loudness the subject was working with. These mean percentage variabilities are shown in Table 2. Corresponding percentage variabilities for the decibel values themselves are also shown in Table 2. These latter values are based on only about half the data, but they are quite representative of the whole array.

In contrast to the "reasonable" behavior of the variabilities computed from the loudness values, the variabilities for the decibel readings show a drastic change along the scale. As a matter of fact, the averaging of decibels would suggest that the subjects are three times more variable when they adjust the tone to the lower quarter point than when they adjust the tone to the upper quarter point. That this unreasonable outcome can be rectified by the simple procedure of dealing with the loudness values themselves, by means of an empirical conversion function, is testimony to the importance of computing our statistics on the proper values and not on a set of arbitrary measures that are nonlinearly related to the values we are concerned with.

One further point deserves mention. In the foregoing example we have treated the data by graphical methods throughout. When, as sometimes happens, it is possible to approximate the relation between loudness and sound intensity by an analytic expression, we can dispense with graphs and use formulas. Since, in our example, loudness is approximately proportional to the cube root of the sound intensity, we can

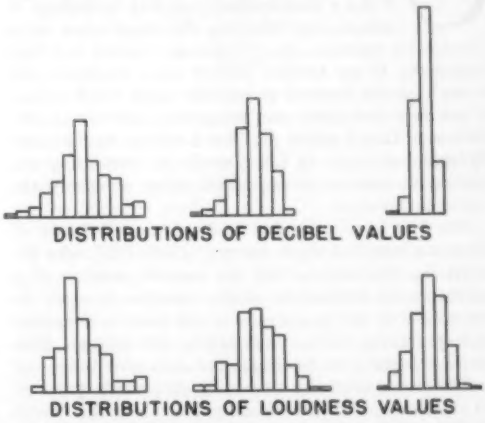

Fig. 2. Each histogram represents 135 adjustments (3 by each of 45 subjects). When measured in loudness values, the adjustments to the midpoint show the largest standard deviation (middle histogram). When measured in decibels, the lowest quarterpoint shows the largest standard deviation. The width of each bar represents 2 db or 5 loudness units, as the case might be.

Table 2. Mean percentage variabilities.

Point on loudness scale	Computed from loudness values	Computed from decibel values
25	8.3	11.8
50	9.9	8.5
75	7.9	3.9

approximate the average of the loudness values by the following procedure.

1) Divide each decibel value by 3.
2) Find the antidecibel values.
3) Average these values.
4) Find the decibel value corresponding to this average.
5) Multiply this decibel value by 3.

This procedure will undo the skewness caused by a cube-root relation between loudness and intensity. For other mathematical relations an analogous procedure can be applied.

Of course, since there are other causes of skewness than the one that concerns us here, the foregoing procedure is no panacea. For some kinds of experimental data the arithmetic mean is a poor measure of central tendency, not because the measurements are made on other than an interval or a ratio scale, but simply because out-sized errors sometimes occur in one direction or another. The resulting skewness can usually best be coped with by resort to medians (*3*).

References and Notes

1. For a fuller discussion of these scales, see S. S. Stevens, "On the theory of scales of measurement," *Science* **103**, 677 (1946); S. S. Stevens, "Mathematics, measurement and psychophysics," in S. S. Stevens, Ed., *Handbook of Experimental Psychology* (Wiley, New York, 1951), chap. 1.
   For other discussions of these scales, see F. B. Silsbee, "Measure for measure: some problems and paradoxes of precision," *J. Wash. Acad. Sci.* **41**, 213 (1951); C. H. Coombs, H. Raiffa and R. M. Thrall, "Some views on mathematical models and measurement theory," *Psychol. Rev.* **61**, 132 (1954); and J. P. Guilford, *Psychometric Methods*, (McGraw-Hill, New York, ed. 2, 1954).
2. Prepared under contract N5ori-76 between Harvard University and the Office of Naval Research, U.S. Navy (project NR142-201, report PNR-155).
3. See, for example, E. C. Poulton and S. S. Stevens, "On the halving and doubling of the loudness of white noise," *J. Acoust. Soc. Amer.*, in press.

Osmotic Pressure

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OSMOTIC pressure no longer occupies the central role in the theory of solutions that it did a half-century ago, but in biology it retains, nevertheless, its importance as a concept, by reason of the membranes existing in living organisms. It has become evident from questions put to me that the theories of solution upon which many, if not most, biologists were brought up are now so old-fashioned that I might perform a service to the large biological clientele of this journal by presenting the subject in modern terms, emphasizing primarily the concepts involved.

The first important step in developing a theory of solutions was that made by van't Hoff, 1887, who derived the relationship that the osmotic pressure of a substance in sufficiently dilute solution is equal in magnitude to the pressure it would have if it existed as a gas in the volume occupied by the solution. This made it possible to determine the molecular weight of a nonvolatile solute by measuring its osmotic pressure in a solution of known concentration. Using this "van't Hoff law" in Carnot cycles, he derived equations relating molecular weight to the lowering of the freezing temperature and the rise in boiling temperature of the solvent. These relationships became the heart of the physical chemistry of a half-century ago. Nernst discussed electrode potentials in terms of balance between emf, solution pressure of an electrode and osmotic pressure of its ion. Every textbook of physical chemistry expounded osmotic pressure at some length, and some investigators made great efforts to measure it with precision.

But this quasi-gas model of solutions, like the first Wright airplane, with the rudder in front, proved to be a poor basis for further progress. It treated the solvent only as providing volume for the quasi-gaseous solute. It is strictly true, as van't Hoff himself pointed out, only at infinite dilution, but many investigators overlooked the restriction and applied it at concentrations where even gases cease to follow the gas laws. One enthusiast determined the freezing temperatures of concentrated solutions of calcium chloride and ascribed all deviations from the formula to the removal of part of the water from its role as solvent. The water of hydration thus calculated exceeded all the water in the vessel. He was, of course, deeply humiliated when a critic pointed this out.

One of van't Hoff's explicitly stated assumptions in deriving the equation for osmotic pressure was that the solute in dilute solution is described by Henry's law, namely, that its partial pressure is proportional to its molar concentration. This had been abundantly verified for dilute solutions of gases, and it is, indeed, almost a logical necessity; the effects of dissolved molecules too far apart to affect one another must be proportional to their number. What was not appre-

ciated in those days was that all the relationships derived from the expression for osmotic pressure could have been obtained directly jointly from Henry's law and the "Gibbs-Duhem" equation connecting the partial vapor pressures of the two components, which is pure thermodynamics, based upon the fact that a solution may be diluted either by distilling out reversibly a certain amount of solute as vapor or by distilling in an equivalent amount of solvent, and that the free energy change is the same for both. An important consequence of this relationship is that in the range of concentration in which the solute follows Henry's law the solvent follows Raoult's law (*1*).

In *Theoretische Chemie* (ed. 3, 1900) by Nernst, the great physicochemical authority of a half-century ago, one may find Raoult's law derived from van't Hoff's law, a roundabout way, as we now see, of getting it from Henry's law.

The foregoing considerations should not be interpreted as implying any lack of respect for men of the caliber of van't Hoff and Nernst. My purpose is only to point out that the approach to solution theory in the books and courses from which at least the older among my readers doubtless studied is far from being as enlightening and adequate as is now possible.

Vapor pressure and osmotic pressure. Let us begin with the purely thermodynamic relationship between the vapor pressure of the component we will call the solvent and the osmotic pressure of the solute against a membrane permeable only to the solvent. This is easily derived by aid of the principle that the change in free energy involved when pure solvent is transferred into a solution reversibly, under equilibrium conditions, is the same whether the transfer takes place by isothermal distillation through the vapor phase or by passage through a membrane against the osmotic pressure. The relationship is

$$\Pi_2 \bar{v}_1 = -RT \ln f_1/f_1^\circ, \qquad (1)$$

where Π_2 is the osmotic pressure of the solute, $\bar{v}_1$ is the partial molar volume of the solvent—the increase in volume of the solution when 1 mole of solvent is added to an infinitely large volume of solution—and f_1° is the fugacity of the pure solvent; f_1 is its fugacity from the solution. The term *fugacity,* or escaping tendency, introduced by G. N. Lewis, is essentially the pressure the vapor would have if it were an ideal gas. Omitted from this equation is a comparatively small term expressing the change in free energy involved in compressing the solution to the hydrostatic pressure Π_2 before adding solvent through the membrane.

Equation 1 shows that osmotic pressure is far larger in magnitude than the corresponding difference in vapor pressure between solvent and solution and is the better property to measure when investigating very dilute solutions. A solution so dilute that the vapor pressure of the solvent would be lowered only 0.1 mm of Hg from 100 mm would, assuming $v_1 = 100$ ml, have an osmotic pressure of 186 mm.

The ideal solution. Equation 1, as it stands, is useless for calculating osmotic pressure from composition, or vice versa. Such a relationship is very simply derived for a solution whose two species of molecule have the same intermolecular forces and volumes, the two liquids mixing with no changes in temperature or volume. In that case the escaping tendency of a single molecule is the same in pure liquid and solution, hence the fugacity of that species is proportional to its fraction of the total number of molecules present. Designating the number of moles of solvent and solute by N_1 and N_2, respectively, we write

$$\frac{f_1}{f_1^\circ} = \frac{N_1}{N_1 + N_2} = x_1 \text{ and } \frac{f_2}{f_2^\circ} = \frac{N_2}{N_1 + N_2} = x_2. \qquad (2)$$

This is the modern expression of Raoult's law for an "ideal solution," discovered empirically by Raoult in 1887. He expressed it in terms of the lowering of vapor pressure

$$(p_1^\circ - p_1)/p_1^\circ = N_2/N_1,$$

a form that failed to suggest its theoretical significance. The osmotic pressure of an ideal solution can now be expressed in terms of composition.

$$\Pi_2 v_1 = RT \ln \frac{(N_1 + N_2)}{N_1}. \qquad (3)$$

The term $(N_1 + N_2)/N_1$ may be written as $1 + N_2/N_1$ and the logarithm expanded:

$$\ln\left(1 + \frac{N_2}{N_1}\right) = \frac{N_2}{N_1}\left[1 + \frac{1}{2}\frac{N_2}{N_1} + \frac{1}{3}\left(\frac{N_2}{N_1}\right)^2 + \dots\right].$$

With dilute solutions, N_2/N_1 is small, and neglecting higher powers we may write,

$$\Pi_2 v_1 = \frac{N_2}{N_1} RT. \qquad (4)$$

Substituting the concentration, $c_2 = N_2/N_1 v_1$, we obtain the original van't Hoff form of the "law,"

$$\Pi_2 = c_2 RT. \qquad (5)$$

We see from the derivation the various assumptions involved, few if any of which would be strictly valid for the systems dealt with by biologists. Thus one obviously should be chary about ascribing causes to the deviations from Eq. 5 that are found for such systems as the biologist studies.

Mechanism of osmotic pressure; role of entropy. There was formerly a great deal of discussion of the cause of osmotic pressure, whether it should be ascribed to attractive forces or to thermal bombardment of the semipermeable membrane by the solute molecules. We now see that it is primarily a consequence of the tendency of two different liquid species, under the impulse of thermal agitation, to achieve a state of maximum disorder by any available path, and that the route via osmosis is no more significant theoretically than one via the vapor state or the solid state. Indeed it makes no difference whether the composition of a solution is changed by adding solvent or by removing the equivalent amount of solute. A dissolved electrolyte might be removed by electrolysis.

The thermodynamic measure of molecular disorder

is entropy, therefore it may be asserted that osmotic pressure is primarily related to entropy. But entropy is a concept that many persons treat as did a certain engineering instructor who could only say, in reply to a student's question, "I don't know what entropy is; nobody knows what it is; you just use it; that's all." Let us try to do better than this for our particular purpose.

We may illustrate the assignment of a numerical value to the disorder of a mixture by considering, first, the two-dimensional system of checkers. If black checkers are put on one-half of a checkerboard and red ones on the other half, and the board is shaken, the pieces will soon be randomly distributed, and the chance that, on repeated shaking, the original segregation will reappear is almost vanishingly small. After most shakings, the ratios of red to black on the two halves of the board will be nearly equal. The mixing results from the shaking only; no attractive forces are involved. Of course, if the black pieces were made of steel, magnetized, and the red of copper, the former would resist mixing, and the degree of randomness would depend upon the violence of shaking.

The amount of entropy involved in mixing n_1 and n_2 molecules of equal size to form a completely random mixture can be formulated in terms of the number of possible ways of arranging the two sorts in the spaces of the instantaneous configuration of the mixture. This need not be a regular lattice. It is exactly like calculating the number of ways in which n_1 black pieces and n_2 red pieces can be arranged upon a board with $n_1 + n_2$ spaces that are not equal squares. It is $(n_1 + n_2)\ !/n_1\ !n_2\ !$. Because entropy should be additive with respect to disorder, we express it as proportional to the logarithm of this expression,

$$S = k \log [(n_1 + n_2)\,!/n_1!n_2!].$$

Using Sterling's theorem and taking $n_1 + n_2$ equal to the Avogadro number, we obtain for the increase in entropy upon mixing $N_1 + N_2$ moles,

$$\Delta S^M = -R(N_1 \ln x_1 + N_2 \ln x_2). \tag{6}$$

The entropy of transferring 1 mole of component 1 from pure liquid, where its entropy is $s_1°$, to solution of composition x_1, where its partial molal entropy is $\bar{s}_1$, is

$$\bar{s}_1 - s_1° = -R \ln x_1. \tag{7}$$

If the molecules are not of the same size, the entropy of mixing is larger. An approximate formula was derived independently by Flory (*2*) and by Huggins (*2*) by considering that one component is a linear polymer, whose units are strung like beads on the sites of an imaginary lattice, the monomer molecules of the solvent occupying the remaining sites. I found that it could be derived also without that restriction (*2*). The equations are

$$\Delta S^M = -R[N_1 \ln \phi_1 + N_2 \ln \phi_2] \tag{8}$$

and

$$\bar{s}_1 - s_1° = -R\left[\ln \phi_1 + \phi_2\left(1 - \frac{v_1}{v_2}\right)\right]. \tag{9}$$

The difference between Eqs. 6 and 8, or 7 and 9, is small when v_1 and v_2 do not differ by a factor of more than 2 or 3, but it becomes enormous if one component is a high polymer. Let us see, next, how such differences would affect the lowering of vapor pressure and the osmotic pressure. This requires resort to the second law of thermodynamics, and I shall give a very elementary, rather intuitive derivation, for the purpose of emphasizing the three concepts involved.

Entropy, energy, and free energy. Certain forms of energy, including kinetic, potential, electric, magnetic, can be, at least in principle, reversibly transformed into one another. But if any of them generate heat, it cannot be quantitatively reconverted into the others. The kinetic energy of, say, a piece of lead moving through space at 0°K would represent an orderly movement of its atoms in parallel paths; but if the object were suddenly stopped by a hard meteorite, its temperature would rise, the orderly motion of the atoms would become disordered, and the probability that they would all suddenly move together as before would be infinitesimal. Any process that is accompanied by an increase in molecular disorder has less capacity for doing work, less free energy, the higher the temperature at which it occurs. Designating the change of free energy and entropy of the system by ΔF and ΔS, respectively, we may translate that statement into mathematical form, writing

$$[\partial(\Delta F)/\partial T]_p = -\Delta S. \tag{10}$$

Also, the heat absorbed in a process will not all be available for doing work if the process involves an increase in molecular disorder, as it does when a gas is liberated, and the excess of ΔH over ΔF should be proportional to the increase in entropy. The proportionality constant is the absolute temperature, and we may write

$$\Delta H - \Delta F = T\Delta S. \tag{11}$$

These are two expressions of the second law of thermodynamics. This way of getting them shows, I trust, why the concept of entropy is necessary and reasonable. It is not a proper derivation, but a good many of our most important concepts, principles and laws have been perceived as hunches and only later derived by the stricter logic of the textbook. I am a strong believer in the desirability of beginning with the concepts rather than a series of mathematical steps.

Let us now pursue our subject by writing under each term of Eq. 11 its value for an ideal solution:

$$\begin{aligned} \bar{F}_1 - F_1° &= \bar{H}_1 - H_1° - T(\bar{s}_1 - s_1°), \\ RT \ln (f_1/f_1°) &= 0 - T(-R \ln x_1). \end{aligned} \tag{12}$$

It follows that $f_1/f_1° = x_1$ (and, of course, $f_2/f_2° = x_2$) and we thus obtain Raoult's law by a more rigid treatment of molecular disorder than the one given earlier.

If we are dealing with components whose molar volumes are unequal but that nevertheless mix "athermally," then Eq. 9 becomes appropriate. Let us see the effect upon osmotic pressure of using a not very high polymer with $v_2 = 10^3 v_1$. Suppose 1 mole of solvent is transferred into a solution where $x_2 = 10^{-3}$ and $x_1 = 0.999$. If $v_1 = v_2$, the entropy of transfer per mole is

from Eq. 7, 0.00197 cal/deg. If the solute is a polymer, with $v_1 = 100$ ml and $v_2 = 10^5 v_1$, Eq. 9 gives 0.39 cal/deg. With $T = 298°K$, the values of $RT \ln(f_1°/f_1)$ are 0.024 lit atm and 4.7 lit atm, and the osmotic pressures, by Eq. 1, are 0.24 and 47 atm, respectively, an enormous difference.

But most solutions are far from ideal, by reason not only of unequal molar volumes but of unequal intermolecular forces: van der Waals, dipole, hydrogen bonding, acid-base, and ionic. These introduce not only changes in configuration, disorder, and therefore entropy but also changes in heat content. No longer can one assume that the entropy of mixing will be correctly predicted by the foregoing equations or that the heat of mixing will be zero. It is worth mentioning, however, that the heat term in Eq. 12 is a quadratic function of the concentration of the solute and, hence, disappears in the limit. For a solution, in which thermal agitation suffices to give random mixing, this term is given approximately by the expression,

$$\overline{H}_1 - H_1° = v_1 \phi_2^2 (\delta_2 - \delta_1)^2,$$

where the δ's are "solubility parameters" expressing the intermolecular forces of solute and solvent. To deal with all these factors is far beyond the scope of so limited a treatment as this, which is intended only to remove some of the mystery that often beclouds the subject and to warn against the drawing of too simple inferences from deviations that may be encountered from the primitive equation, $\Pi = c_2 RT$. The emphasis upon the role of entropy in modern solution theory is in striking contrast to its neglect during the period when the theory was based upon osmotic pressure. In Nernst's *Theoretische Chemie*, there is but one reference to entropy. It is in small type and consists of an argument for not using it! Today, no physical or natural scientist can afford to be utterly ignorant of entropy.

References

1. For derivations, see J. H. Hildebrand and R. L. Scott, *Solubility of Nonelectrolytes* (Reinhold, New York, 1950).
2. For references and detailed discussion, see reference 1, Chapters VI and XX; also J. H. Hildebrand *J. Chem. Phys.* **15**, 225 (1947).

The European Oyster in American Waters

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THE common European oyster, *Ostrea edulis* L., which occurs along the Atlantic Coast of Europe from Norway to Spain, in the British Isles, and the western part of the Mediterranean, may propagate at a somewhat lower temperature than our native oyster, *Crassostrea virginica* Gmelin. We thought, therefore, that the European oyster might be introduced into this country (*1*) to occupy eventually a definite ecologic niche in areas where the water is too cold for the successful propagation of our native oyster but is still sufficiently warm to be within the propagating temperature range of *O. edulis*. Among such areas are certain bodies of water along the shoreline of Maine and some well-protected bays and harbors of our Pacific Coast states.

The oysters were shipped to us from the Oosterschelde, Holland, by P. Korringa late in September 1949 and were placed in Milford Harbor on 11 October. The shipment consisted of approximately 9000 oysters representing 3 year-classes, that is, the 1947, 1948, and 1949 sets. Because of the long trip approximately 13 percent died soon after arrival, the mortality being heaviest among the youngest year-class.

The oysters were intended chiefly for studies to determine whether they would survive and propagate under the ecologic conditions to which they would be subjected in this country. Simultaneously with these studies, observations were also made on the seasonal gonadal changes of the oysters kept in different localities, their rate of growth, artificial propagation, and several other aspects of their biology.

Some of the oysters were left in Milford Harbor, but the others were transplanted to four localities of Maine, including Boothbay Harbor. The oysters grew well in all regions. Their mortality in Milford did not exceed, in general, that of the native oyster living in the same environment. Each winter since their arrival from Europe the oysters have lived under a layer of ice, at least for some time. In Milford Harbor, an estuary strongly affected by river discharge, the oysters were subjected, especially in the spring, to prolonged periods of low salinity but, nevertheless, survived, a fact indicating that they possess good tolerance in this respect.

The European oysters were noticeably affected if the turbidity of the water, whether caused by silt or high concentrations of microorganisms, was relatively high. We even witnessed cases of abortion of embryos and immature larvae by gravid females that had been exposed to a dense concentration of dinoflagellates belonging to the genera *Prorocentrum* and *Gymnodinium*. The larvae were expelled in pseudofeces imbedded in mucus along with masses of dinoflagellates. The abortion was usually complete, removing all larvae from the mantle cavity where they are nor-

mally carried by the mother oyster. This observation suggests that such a natural phenomenon as the "red tide" may often be responsible for the complete extermination of embryos and larvae of larviparous species of bivalves.

Observations on living individuals and histologic studies of preserved samples showed that the oysters kept in Milford Harbor and in Maine developed normal gonads, spawned, and released larvae. In Milford Harbor larvae-bearing oysters were found from the beginning of July until the end of August. In Boothbay Harbor, where the summer is shorter and the temperature lower, the larvae-producing season is probably correspondingly shorter.

Regardless of the relatively small number of adult oysters planted in Boothbay Harbor, which even at the beginning of the observations was only about 3000 individuals, approximately 50 young oysters originating from the imported parents were found attached to rocks, shells, sticks, and so forth, on the bank approximately ¼ mi from the parents. The young oysters were found confined to the +1- to −3-ft tidal level. Judging by their sizes and other characteristics, this group consisted of individuals of three different year-classes, namely, those that set in 1950, 1951, and 1952. In the fall of 1953 the smallest oyster measured was 10.0 mm, but the largest was already 88.0 mm. The finding of so many young, thriving oysters indicates conclusively that European oysters may become successfully established in our waters.

Good growth was also shown by the adult oysters that came from Holland. For example, the largest oyster among the oldest, 1947, year-class, upon arrival here in 1949 measured slightly more than 90.0 mm. In the fall of 1953 some oysters of the same group already exceeded 120.0 mm in size.

Using our methods for ripening mollusks and for inducing their spawning out of season (*2*), we obtained larvae of *O. edulis* throughout the greater portion of the year. Swarms of larvae were released in the laboratory from the beginning of February until the end of the normal spawning season. The larvae were grown through metamorphosis in hatching jars, and in large outdoor tanks with a capacity of several thousand gallons (*3*). Many of these young oysters were later shipped to other places, including the shellfish laboratory of the State of Washington. According to C. E. Lindsay, director of that laboratory, some of this set, which was shipped there in 1951 and planted in North Bay, had reached 77.0 mm in length by August 1954.

Thus our observations have shown that *O. edulis* may survive, grow, and propagate in New England waters and that the young oysters, reared at Milford and sent to Washington, grow well there. They suggest that the introduction of this oyster in certain areas of the United States, and possibly Canada, may eventually lead to the establishment of a new and prosperous shellfish industry.

In introducing a foreign species it should be emphasized that certain precautions should be exercised. First, it should be considered whether the newcomer will engage in biological competition with some of the useful local forms and, perhaps, even displace them from their established niche. A well-known case of such biological competition is the struggle between the highly prized European oyster, *Ostrea edulis,* and the Portuguese oyster, *Crassostrea angulata* Lamarck, which until the middle of the 19th century was confined to the Mediterranean and not found on the Atlantic Coast of France. However, since gaining foothold in the new environment, the Portuguese oyster has rapidly spread throughout a large part of the area formerly occupied only by *O. edulis,* being sometimes responsible for the complete disappearance of the latter in some sections of the coast. The victory of the Portuguese oyster over the native one was ascribed to several factors, of which the chief were that the Portuguese oyster is more prolific, grows faster, and in feeding pumps more water than *O. edulis* (*4*), thus often depriving the European oyster of living space and food.

Another well-known example of an introduced competitor is the small gastropod, *Crepidula fornicata* L., commonly called "slipper-shell" or "quarter-decker" which, in the 1880's, was unintentionally carried along with shipments of American oysters to England, and later extended its range into the coastal waters of western Europe. In both places it quickly multiplied to such an extent that it smothered not only oyster set grown on special tile collectors but occasionally even the beds consisting of adult oysters. The same pest was also introduced to our Pacific Coast where it quickly became a dangerous competitor of the native oyster, *Ostrea lurida* Carpenter.

It is even more important to be certain that, together with the introduced species, we are not bringing along some of the ecologically associated forms which in the new environment may become either serious predators of native commercial species or cause other problems, for example, heavy fouling. An example of the former was the introduction of the American oyster drill, *Urosalpinx cinerea* Say, to our Pacific Coast and to England, and the Japanese drill, *Tritonalia japonica* Dunker, to the oyster beds of our Pacific Northwest. In both places the drills rapidly multiplied and soon began causing heavy losses among the native, as well as the introduced oysters.

A good representative of the second group, one that may cause serious fouling, is the Australian barnacle, *Elminius modestus* Darwin, which recently gained entrance to the waters of Europe and is creating serious difficulties there, being a dominant sedentary organism in the intertidal zone (*5*).

Thus, in principle, the introduction of a new species, whether plant or animal, should always be considered as a potentially dangerous undertaking because of the possibility of bringing along undesirable forms which, in a new environment, could rapidly become pests of major significance, just as the Japanese beetle has become in this country. We think, there-

fore, that the safest way to build up a population of foreign oysters or other useful bivalves, would be to import a small number of adults, which upon arrival should be kept under such conditions that undesirable forms, incidentally brought along with them, would not gain entrance to the native waters. Later, by using the modern methods of lamellibranch culture (*6*), the spawn of these adults could be used for rearing, under rigidly controlled laboratory conditions, a sufficient number of pest-free individuals for the establishment of initial spawning beds.

References and Notes

1. I wish to express thanks to my colleagues at Milford Laboratory for cooperating with me in many phases of these studies, to the members of the Fish and Wildlife Service at Boothbay Harbor and of the State of Maine Sea and Shore Fisheries who made numerous observations on the oysters planted in Maine, and to C. E. Lindsay of the State of Washington for informing me of the fate of the seed oysters which we shipped there.
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News and Notes

Solar Energy and Wind Power

The Government of India organized a symposium on *Wind Power and Solar Energy* in New Delhi, India, 22–26 Oct. The UNESCO Committee on Arid Zone Research joined with India in sponsoring this conference, the purpose of which was to study the possibilities of using wind power and solar energy, particularly in arid regions.

The 28 scientists from 20 different nations included physicists, engineers, chemists, meteorologists, and botanists, each offering his experience and specialized techniques in an attempt to provide more power and more comforts for people who live in areas where fuels for mechanical power are limited or nonexistent. The difficulty with using sunlight is the low intensity of energy and the large area that has to be covered with any energy-receiving material.

Solar heaters for cooking, house heating, and operating engines were described in detail. Several solar cookers that gave heat equivalent to 350 watts were demonstrated at the National Institute of Physics of India. The parabolic mirrors were about 3 ft in diameter. Another type, developed by L. Gardner of New Delhi, consisted of many small flat mirrors attached to wooden arms with parabolic edges, arranged in such a way that each arm is adjusted at frequent intervals, to focus the sunlight onto a vessel of boiling water. The solar cookers were regarded as important because, if they can be made cheaply enough, they can be used in rural houses instead of the stoves that now burn cow dung or shrubs and grass. The dung should be used for fertilizer and the vegetation should be used to protect the soil against erosion. The present selling price of the solar cooker in India is $14, but this is too high and it was generally agreed that solar cookers would have to be sold for $5 or less in order to be widely accepted. Thin mirrorized plastics in parabolic shapes were suggested in place of the metallic reflectors.

In heating houses with solar energy the problem is simplified by the fact that high temperatures are not needed and no focusing device is required. The heat can be stored in hot water tanks, in beds of small rocks, or in chemicals such as hydrated salts. A large expansion in the number of solar-heated houses is expected in the colder climates and here again valuable trees, shrubs, and grass can be conserved if cheap solar heating equipment can be developed. The problem is to find a way of collecting and storing the sun's heat with a minimum of invested capital. Thin plastics offer promise as a cheap material.

House cooling and refrigeration are also important. V. A. Baum of the U.S.S.R described a refrigerating machine in which a solar engine produced 250 kg of ice per day.

The solar distillation of salt water was reviewed; it seems likely that distillation can be economical in areas where fresh water is at a high premium. Here again, the new hope lies in using thin plastic tubes of large area. Extensive tests will be carried out in several different laboratories to test the length of life of plastic materials under operating conditions in bright sunlight. It was pointed out that there are several areas in Asia and Africa where the solar distillation of sea water and brackish water from wells would be of great help. It was emphasized in one specific case that 2000 gal/day are needed for a fish cannery on the eastern coast of Africa and that this water is now brought long distances by ship. Production of this amount of water by solar distillation could be started soon.

Perhaps the greatest emphasis of the conference was placed on solar engines. Most of the work described involved the use of large parabolic mirrors focusing the light onto water boilers. K. N. Mathur and F. Khanna of the Indian National Institute of Physics demonstrated several different models. V. A. Baum of U.S.S.R. described large installations that generate steam for engines up to 7 atm and he gave plans for still larger installations. Several additional applications of solar energy were shown by Baum with the help of motion pictures.

Steam engines with flat plate collectors instead of parabolic mirrors were discussed and a type of gas engine was mentioned in which the gas could be alternately expanded and contracted by intermittent exposure to sunlight.

Three papers were devoted to meteorology and the recording and interpretation of solar data. Particu-

larly significant data including the importance of scattered radiation from clouds was reported by A. E. H. Bleksley of South Africa. The water problems in northwest India were described in detail and it was pointed out that many arid regions have water below the surface that can be used for irrigation if solar power and wind power are available.

H. Masson of French West Africa described fundamental studies on the heating of water in various types of troughs.

It is an anomaly that although solar energy is difficult to use because it is so low in intensity, it nevertheless can be used for experimental furnaces of the highest temperatures under conditions where fuel gases and electric heating coils are not a source of contamination. F. Trombe of France described in detail the very large parabolic reflectors and the high temperatures he is obtaining for experimental purposes. He described the technique of putting together many small flat mirrors to give an effective parabolic mirror of large area.

Power for simplified steam engines from the burning of leaves and vegetation was discussed. N. W. Pirie of England made the point that small plants, such as beans, might well be more effective in utilizing solar energy than algae. Plants that cover an entire area with green leaves may well compete with algae for mass production by photosynthesis and they are less subject to contamination than algae and can be readily harvested. Pirie suggested the squeezing of vegetable material of this type to extract soluble, edible carbohydrates and proteins. The residue of cellulose and other materials would be used for fuel. He suggested that water narcissus might well give very large yields of organic material per year and pointed out that to get maximum productivity from photosynthesis an area must be covered with green material throughout the whole growing season—in the tropics the growing season would be the whole year.

Nearly half of the symposium was devoted to wind power. I. D. Dresden of the Netherlands, U. Hütter of West Germany, and J. Juul of Denmark, and E. W. Golding of England led in these discussions. Much greater refinement is needed in reporting wind velocities in an area where windmills are under consideration. Many observations in a given area have shown that wind velocities may often be much more favorable for windmills than indicated by the wind velocities that are being reported from the present weather observatories. There were several suggestions, both with regard to wind and sun, that the science of micrometeorology should be expanded.

It was pointed out that windmills must have velocities of 10 mi/hr or more in order to be really useful. It was reported that winds greater than 10 mi/hr are not frequent in India and the outlook for windmills did not seem to be very hopeful there except in particular areas. Suggestions for some different types of windmills were made. The hope of using windmills and solar engines in the nonindustrialized areas depends on making the equipment so simple that the capital investment is low. Golding reported a new expansion of windmills and rural electrification in England and in other parts of the world. The possibilities of working electric generators and windmills into a rural electrification grid system were discussed. Hütter emphasized the importance of storing energy from intermittent windmills and solar engines. Among other suggestions was the use of a large sphere of cast iron to be heated by electric heating coils, to 600 or 700°C. The large heat capacity and the small area would tend to conserve heat which could later be used for operating vapor engines.

The organization and arrangements for the symposium were carried out by J. Swarbrick of the UNESCO office in Paris, and W. J. Ellis and Philip Young of the UNESCO office in India. M. S. Thacker of Bangalore was the able chairman of the committee on arid zone research and shared with Krishnan of the National Physical Laboratory the duties of chairman for the symposium. The participants of the conference were grateful for the opportunities of the conference and the study tour and for the splendid Indian hospitality arranged by Thacker and his associates.

After the symposium was completed, the group of 28 scientists was taken on a study tour as guests of the Government of India. The arid regions of northwest India were visited and the great need for developing solar engines or some means for raising water for irrigation was clearly evident. In many areas teams of bullocks were used for raising the water for irrigation and it is to be hoped that some of this labor can be replaced.

It was emphasized constantly that high efficiency of solar devices is relatively unimportant in sunny nonindustrialized areas. Low cost of installation per unit of power is much more important than the amount of power produced by a ton of coal or a gallon of gasoline. The solar energy is essentially free and it is available everywhere. Although solar energy and wind power cannot now compete with fossil fuel in an industrialized community where fuel is plentiful, they may compete with animal and man power.

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Typhoons

A UNESCO symposium on *Typhoons* was held in Tokyo 9–13 Nov. 1954. Attending were official delegates from 13 countries of southern and eastern Asia from Pakistan to Japan and representatives of the American Armed Forces, U.S. Weather Bureau, and universities. All countries endangered by typhoons in the area were represented except Ceylon and Russia, neither of which sent delegates, and Red China, which is not a member of UNESCO. K. Wadati of Japan was elected chairman, and G. S. P. Heywood of Hong Kong, vice chairman.

After the introductory organizational meeting, the discussion turned to the "Prevention of disaster

caused by typhoons." Three main forces were examined: the force of the wind itself and the resulting damage, the floods caused by the heavy rains, and the high storm tides that sometimes occur. In each case the topography of the land or the sea floor was shown to affect the intensity of the damage.

One day was devoted to the "Structure of typhoons." The highlight of this session was a discussion of the structure of hurricanes off the east coast of the United States as explored by weather reconnaissance planes. R. H. Simpson of the U.S. Weather Bureau ended his talk by showing several colored slides he had taken in the eye of a typhoon south of Bermuda.

On the third day the "Formation and development of typhoons" and the "Movement of typhoons" were considered. Progress in determining why one tropical depression will develop into a typhoon and an apparently similar one will not is slow and controversial. A promising development for forecasting the movement of typhoons appears to be the modification of numerical forecasting methods now used for the westerlies [*Science* **120**, 408 (1954)] to tropical latitudes.

The status of present and planned research on typhoons was discussed on the fourth day. Only the larger organizations such as those in the United States and Japan can support extensive research; the smaller countries such as Macao and the Philippines have neither the money nor the manpower to do more than routine work.

Perhaps the outstanding feature of the symposium was the emphasis on the practical aspects of the problem. In this region where communication between scientists is comparatively poor and the exchange of information by means of journals is rendered difficult by government currency restrictions, the conference served as an inspiration and as a place to exchange information that can be adapted by each participant to his local problems. It is hoped the proceedings of the symposium will be published by spring.

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Science News

The Scientists' Committee on Loyalty and Security of the Federation of American Scientists has issued an appeal for information concerning **cases in which grants to individual scientists have been denied** by the U.S. Public Health Service because of questions regarding loyalty. According to the committee, the fact that grants have been withheld has been established in one or two instances, and, on 21 Apr., Secretary Hobby confirmed that such action had taken place but indicated that the cases were limited in number. The committee has stated that it does not wish to criticize any division of the Government without being quite certain that there is adequate cause for criticism. Information should be addressed to Ernest Pollard, chairman, 2153 Yale Station, New Haven, Conn.

Orda Plunkett, Robert Lubarsky, and Frank Swatek of the department of botany at the University of California at Los Angeles report that, contrary to previous belief, wild rodents are not an important reservoir for organisms that cause valley fever, or **coccidioidomycosis**—a respiratory disease found in the Southwest. More than 1100 wild rats, mice, and rabbits were trapped in various southern California areas. Only eight of the animals, 0.7 of 1 percent, yielded evidence of infection.

British surveyors set 29,002 ft as the **official height of Mount Everest** more than 100 yr ago; however, for some years few experts have considered the figure accurate. Even so, it has stood because none of the many subsequent and higher estimates seemed precise. Recently a new computation of 29,028 ft was reported to the National Geographic Society by I. H. R. Wilson, Surveyor General of India, as the measurement now officially accepted by the Government of India. The new figure may be off 10 ft either way because of seasonal fluctuations in the snow depth on Everest's limestone summit.

According to a recent study of students who traveled to Europe during the summer of 1953, the American tourist is no more likely to acquire a serious parasitic intestinal infection in Europe than he would traveling within the borders of his own country. There also appears to be little scientific basis for the widespread view that "water, change in diet or viruses" cause the minor, but annoying **diarrhea that harasses the American tourist** overseas. B. H. Kean, assistant professor of public health and preventive medicine, and Wilson G. Smillie, professor of public health and preventive medicine, both of Cornell University Medical College, conducted the survey with the aid of a grant from the New York Hospital–Cornell University Medical College Research Fund; their findings are reported in the 16 Sept. 1954 issue of the *New England Journal of Medicine*.

Only six students (2.7 percent) acquired amebic infection in a group of 222 American students who volunteered for both series of tests conducted on eastbound and westbound voyages. It is likely, the report observes, that examination of a comparable group of students "who took their vacations anywhere in the United States would reveal an equally high percentage."

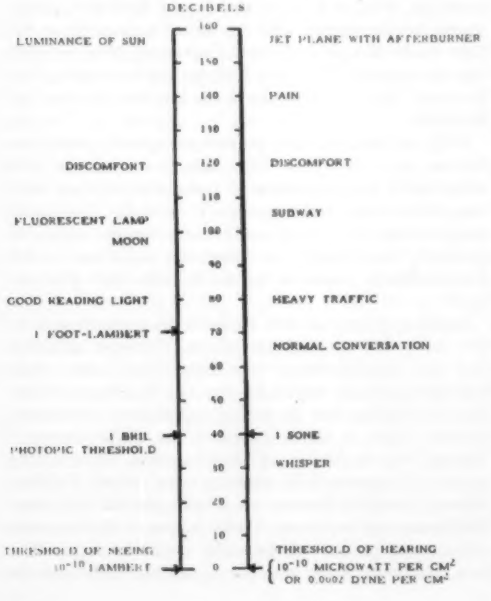
Another group of 360 students also cooperated in this study of intestinal protozoans. Evidence indicates that the diarrhea which was reported by more than half the students might be due not to unaccustomed food or water, but to eating substances containing "toxins such as those produced by staphylococci." Because the incidence of diarrhea was considerably higher (71 percent) in students who visited Mediterranean countries than in those who visited only non-Mediterranean countries, it was suggested that warmer climate and poorer refrigeration might be major factors. However, there was no significant difference in

the occurrence of serious intestinal infection in the two groups of travelers.

Facilities for this study were provided by the Council on Student Travel, New York, a nonprofit educational corporation with a nation-wide membership of 34 educational and religious organizations. These organizations conduct international student travel programs that send abroad 5000 students annually.

Soon to be published in *Science* is an article by Herzog, Nobile, Tolksdorf, Charney, Hershberg, Perlman, and Pechet, describing the physical characteristics of two new biologically active steroids with cortisonelike activity. The structures of these **new antiarthritic drugs** are as follows: metacortandracin (Meticorten, Schering) Δ1,4-pregnodiene-17α,21-diol-3,11,20-trione; and metacortandralone (Metacortalone, Schering) Δ1,4-pregnadiene-11β,17α-21-triol-3,20-dione. The use of these drugs in the treatment of rheumatoid arthritis was discussed by J. J. Bunim, National Institutes of Health, at a conference at the New York Academy of Sciences on 26 Jan. The new drugs were synthesized in the laboratories of the Schering Corporation, Bloomfield, N.J.

A comparative decibel rating **chart for varying intensities of sight and sound** has been developed by S. S. Stevens, director of the Psycho-Acoustic Laboratory at Harvard University. The chart compares the pain experienced by looking directly at the sun (left scale of chart) with a sound equivalent, the noise of a jet plane at full power (right scale of chart), and places these at the extreme discomfort level. Other sight-sound comparisons on the chart range downward to zero, the threshold point of normal vision and hearing.



Increased interest in the **conservation of fine art objects** (or restoration, as the process is more popularly known) has resulted, according to R. L. Feller, Mellon Institute, Pittsburgh, from the foundation of grants and fellowships at various art institutes for research in the field. Feller, who is the author of a technical paper on "Dammar and mastic infrared analysis" [*Science* **120**, 1069 (1954)] informs us that

> . . . An extensive literature has developed in the last 25 yr owing to technical studies in the fine arts, particularly at laboratories in museums in Boston, London, and Brussels. . . . In 1950, the National Gallery of Art, Washington, D.C., established a fellowship at Mellon Institute, Pittsburgh, Pa., to investigate new materials for the fine arts, both for original works and for conservation. In England, the Nuffield Foundation has also established a grant for fundamental research at the National Gallery, London. At Mellon Institute, chemists have devoted first attention to a special study of lacquer or spirit-type varnishes. . . . The traditional materials of the artist, natural resins, drying oils, gums, and "secret formulas," are generally complex mixtures which present a challenging problem to the analyst.

The use of radar to supply information about the structure, density, and movements of flying swarms of locusts is reported in the 8 Jan. issue of *Nature* by R. C. Rainey of the Desert Locust Survey Headquarters, Nairobi, Kenya. The first **radar-sighting of locusts** was recorded on 22 Mar. 1954 in the Persian Gulf by H.M.S. *Wild Goose*. Radar data make it possible to combat swarms by spraying them in midair from airplanes.

Discovery of a **diet that will raise the I.Q.** of mentally defective children suffering from the rare condition, phenylketonuria, is announced by L. I. Woolf, Ruth Griffiths, and Alan Moncrieff of the Hospital for Sick Children, London, in a recent issue of the *British Medical Journal*. Three small children, two of them idiots and one an imbecile, have been fed this diet for from 4½ to 10 mo. The mental ages of all three have increased at a marked rate, and they may reach an intelligence level that will allow them to attend school.

The previous lack of mental development in these children was the result of a defect in the way their bodies handled the amino acid phenylalanine. About four out of every 100,000 population are born with this defect. Since phenylalanine poisoning caused the mental deficiency, Woolf decided to devise a diet that would not contain this material. Since all dietary proteins are about equally rich in content of this particular amino acid, Woolf used an acid hydrolysate of the protein, casein, which contains all amino acids necessary for good nutrition, and treated it with charcoal to extract the unwanted phenylalanine. This treatment also removed tryptophan and tyrosine, both of which were replaced in the mixture.

The material was fed as a soup cooked with starch and water. Since the patients were young and backward, the oldest being 5 yr old, with a mental age of

8 mo, soup feedings were particularly suitable for them. As they progressed in mentality, a special kind of sugar cookie was allowed. The patients were also fed as much water, orange juice, and sugar-water as they wanted, as well as vitamins and minerals. For a child with a mental age of more than 2 yr, potatoes, carrots, and cabbage were added to the diet and the amino acid mixture was fed as a thick gravy flavored with tomato puree. Some patients with epilepsy might also be helped, the studies suggest, since one of the three children stopped having attacks of epilepsy, which had also afflicted him.

Scientists in the News

James M. Mitchell, Deputy Assistant Secretary of Defense, has become assistant to the director of the National Science Foundation. The appointment was announced by Alan T. Waterman, director of the Foundation. Mitchell will be concerned with the foundation's program of fact-finding studies on scientific activities and manpower in government, industry, and universities.

Robert A. Ramey, Jr., manager of the magnetic development section of the materials engineering department of the Westinghouse Electric Corp., Pittsburgh, has been appointed visiting Webster professor of electrical engineering at Massachusetts Institute of Technology for the second semester of the current academic year. During his stay at M.I.T., which commences 1 Feb., Ramey will participate in the development of teaching and research in the new area of solid state nonlinear devices and their applications to power modulators.

Ludwig Biermann has been appointed visiting professor of astrophysics at California Institute of Technology for the current term. One of the leading theoretical astrophysicists in Europe, Biermann is on leave from the Max Planck Institute and the University of Göttingen in Göttingen, Germany. He will conduct a graduate course on the astrophysical theory of stellar magnetism and plasma physics.

Frank H. Riddle, vice president of the Champion Spark Plug Co., Detroit, Mich., has been named 1955 recipient of the Albert Victor Bleininger award. The award is the highest honor conferred in this country for distinguished achievement in the field of ceramics and is given annually by the Pittsburgh section of the American Ceramic Society. The presentation will take place in March.

Ernest M. Gruenberg, executive director of the New York State Mental Health Commission, has resigned to accept a position with the Milbank Memorial Fund. He assumed his duties as a senior member of the technical staff in charge of the fund's mental health activities on 1 Jan.

Carl J. Wessel, associate director of the Prevention of Deterioration Center, Division of Chemistry and Chemical Technology, National Research Council, Washington, D.C., has been appointed director.

Frederic W. Heimberger, vice president for faculty, curriculum, and research, Ohio State University, has been named chairman of the university's newly created Advisory Council on Research. The new 16-member council will serve as a central campus agency to encourage, assist, and give broad direction to the total research effort of the university. Some of the other members are **J. M. Birkeland,** department of bacteriology, **E. L. Bowers,** department of economics, **F. E. Deatherage,** department of agricultural biochemistry, **M. S. Newman,** department of chemistry, **W. G. Venzke,** department of veterinary science, **G. L. Von Eschen,** department of aeronautical engineering, **G. B. Carson,** College of Engineering, **C. A. Doan,** College of Medicine, and **O. C. Woolpert,** executive director of the Research Foundation.

Kenneth S. Cole, former technical director of the Naval Medical Research Institute, Bethesda, Md., has been appointed chief of the laboratory of biophysics, National Institute of Neurological Diseases and Blindness of the National Institutes of Health. His new duties will involve the direction and coordination of a fundamental biophysical research program in the fields of neurological diseases and sensory disorders.

Leland G. Butler, agronomist, has been appointed director of technical service and development in the eastern United States for Standard Agricultural Chemicals, Inc., Hoboken, N.J. Butler recently spent a year in Venezuela experimenting with chemical weed control among food crops as a fellow of the research institute of the International Basic Economy Corp.

Lawrence R. Hafstad, who retired recently as director of the Atomic Energy Commission's division of reactor development [*Science* **120**, 967 (10 Dec. 1954)], has been granted the AEC's distinguished service award.

S. Norman Feingold, executive director of the Jewish vocational service of greater Boston, has been appointed by Governor Herter of Massachusetts to a newly established council on the employment of the aging. His appointment is for 2 yr.

William Q. Wolfson is on military leave from his position as director of the unit for metabolic research at Wayne University College of Medicine and is at present serving as chief of professional services of the U.S. Army Hospital located at American Hospital in Paris. Mail originating in the U.S. should be addressed to Maj. William Q. Wolfson 01934624, U.S. Army Hospital, Paris, France, A.P.O. 55, N.Y.

The Astronomical Society of the Pacific has awarded its Catherine Wolf Bruce gold medal for 1955 to **Walter Baade** of the Mount Wilson and Palomar Observatories. He was chosen for the award by the directors of the Astronomical Society from a list of nominees submitted by the directors of six large observatories, three in the United States and three abroad. He is being honored for his investigations of the structural features and stellar content of systems of stars.

Necrology

Maurice A. Bigelow, 82, author and professor emeritus of biology at Columbia University, New York, 6 Jan.; **Harry Freund,** 49, author and specialist in internal medicine, Brooklyn, N.Y., 9 Jan.; **Albert P. Godsho,** 60, engineer of transmission and protection for Bell Telephone Co., Philadelphia, 7 Jan.; **Doris Harrison Holtzman,** 33, assistant professor of biology at Long Island University, Brooklyn, N.Y., 26 Dec.; **Dwight L. Hopkins,** 55, protozoologist and professor of biological sciences at the University of Illinois, Chicago, 10 Jan.; **Max Jakob,** 75, authority on heat transfer, author, and research professor in the mechanical engineering department of Illinois Institute of Technology, Chicago, 4 Jan.

Arthur B. Keith, 88, anthropologist, author, former rector of the University of Aberdeen, former president of the British Association for the Advancement of Science, and master of Buxton Browne Research Farm, Downe, Kent, England, 7 Jan.; **Thomas F. Manns,** 78, professor emeritus of plant pathology and soil bacteriology at the University of Delaware, Newark, Del., 22 Dec.; **Lionel S. Marks,** 83, authority on engine design, pioneer in combustion engine development, author, and Gordon McKay professor of mechanical engineering emeritus at Harvard University, Cambridge, Mass., 6 Jan.; **Miner R. Salmon,** 45, former teaching assistant at Columbia University and research food chemist for Thomas J. Lipton, Inc., Hoboken, N.J., 6 Jan.; **John W. Schlegel,** 76, retired chief chemist for the National Sugar Refinery, Long Island City, Queens, N.Y., 13 Jan.; **James W. Sherrill,** 64, authority on diabetes treatment and medical director of the Scripps Metabolic Clinic, La Jolla, Calif., 4 Jan.; **Paul Wallworth,** 64, pioneer in the development of modern rice farming methods, Stuttgart, Ark., 6 Jan.

Meetings

"More realistic science teaching—toward what ends?" will be the theme of the 1955 national convention of the **National Science Teachers Association** that will be held 24–26 Mar. at the Netherland Plaza Hotel, Cincinnati, Ohio. Special sections for elementary science as well as high school and college science will be included in the symposiums, panels, clinics, and "Here's-how-I-do-it" sessions. There will be some 13 work-discussion groups, and showings of science teaching films will be offered in several continuous sessions. A new program feature will be the sessions devoted to reviews of recent research in science and the implications for the use of such research results in the strengthening of teaching.

Among the speakers for general sessions are Robert Havighurst, University of Chicago, "Science and intelligent choice;" Harold Fawcett, Ohio State University, "Science and the nature of proof;" and Hubert N. Alyea, Princeton University, who will present one of his popular lecture demonstrations. The AAAS will be represented by its new president, George W. Beadle, California Institute of Technology.

Among the science educators who will be leading the symposiums are Gerald S. Craig, Teachers College, Columbia University, for elementary science; James G. Harlow, University of Chicago, for teacher education; Hubert Evans, Teachers College, Columbia University, for research in science education; Philip G. Johnson, Cornell University, for sponsored programs for improving teaching.

Among those participating in the clinic sessions will be Paul Brandwein, Forest Hills High School, New York City, "Science teaching for gifted high school students;" Harold Alberty, Ohio State University, "Science and the core program;" Rose Lammel, New York University, "Science for elementary children."

The 3rd International Congress of Biochemistry organized by the Belgian Society of Biochemistry under the auspices of the International Union of Biochemistry will convene in Brussels 1–6 Aug. 1955. The scientific program will include (i) 32 symposium sessions, (ii) sessions for members' communications, and (iii) general lectures. Registration accompanied by the appropriate fees must be made *not later than 31 May 1955* at any of the branch offices of the American Express Co. from whom may also be secured any further information concerning the congress.

The **Aero Medical Association** will hold its 26th annual meeting at the Hotel Statler, Washington, D.C., 20–23 Mar. Medical people from many countries are expected to participate. For information, communicate with the head of the association, Gen. Otis O. Benson, Jr., of the U.S. Air Force Medical Service, Washington 25, D.C.

The following paragraphs concerning a meeting on **race relations,** which were abstracted from an item in *News from the Pacific* (vol. 5, Nos. 3 and 4), appeared in the December *Information Bulletin* of the Pacific Science Association.

During July 1954 some 40 sociologists, anthropologists, historians, economists, students of government, and other social scientists gathered at the University of Hawaii for a 4-wk study of race relations in world perspective. Supported by grants from the Ford and McInerny Foundations and jointly sponsored by the universities of Chicago, California, and Hawaii, the conference sought "to re-

view the state of scientific knowledge about race relations in world-wide perspective" and thus to establish facilities for a continuing sharing of knowledge concerning the nature of race relations. Students of the racial situation on six continents attended.

The immediate results of the conference will appear in two volumes to be published within the next year. One of the major achievements of the meeting was the founding of the International Society for the Scientific Study of Race Relations to carry on the activities inaugurated at the conference and to encourage research in race relations in those critical areas of the world where such activities are now limited or nonexistent.

The 6th **National Gastrointestinal Cancer Conference** will be held in the New York Academy of Medicine, New York, 4–5 Apr., with the New York Cancer Society acting as host. The conference is sponsored by the gastrointestinal cancer committee of the National Advisory Cancer Council, National Cancer Institute, Bethesda, Md., and is a continuation of the committee's activities in stimulating the interest of investigators in, and disseminating information about, the gastrointestinal cancer problem. Clinical aspects of the subject will be emphasized in the program of the conference. All interested scientists are invited to attend.

The **Symposium on Molecular Structure and Spectroscopy** will be held in the department of physics and astronomy at Ohio State University, 13–17 June. There will be discussions of both the interpretation of molecular spectroscopic data and the methods for obtaining such data. In addition, there will be sessions devoted to other phases of spectroscopy. A dormitory will be available for those who wish to reside on the campus during the meeting. For further information, or for a copy of the program when it becomes available, write to Prof. H. H. Nielsen, Dept. of Physics and Astronomy, Ohio State University, Columbus 10.

Education

The **John A. Hartford Foundation** has awarded **Yale University** $3,160,000 for research and training in biophysics and for the construction of a new 10,000-ft² research laboratory. Yale will receive the funds in the form of an annual grant of $180,000 for the next 15 yr; an allotment of $460,000 will be provided for construction of the new laboratory, which will be located on the Hartford Foundation's property in Valhalla, N.Y., near White Plains. The instructional phase of the new biophysics program will be centered in New Haven, while research activities are to be conducted both at Yale and at Valhalla.

Ernest C. Pollard, professor of biophysics at the university and a leading figure in this recently developed science, will be chairman of a new department of biophysics. Until now, biophysics at Yale has been predominantly a part of the physics department. The staff of the new department will be almost double the present faculty now interested in biophysics. It will include physicists, chemists, biologists, and physicians. Franklin Hutchinson, assistant professor of radiation phyics at Yale, will be resident director of the Valhalla laboratory next year, a position that will be filled on a rotating basis.

During a half-year leave of absence from Yale starting on 1 Feb., Pollard will spend some time at the Hartford Foundation's house in Valhalla. This house will be used as the library and living quarters for the biophysics laboratory staff. The remainder of Pollard's leave will be devoted to studying biophysics in the Radiological Research Unit of the Mt. Vernon Hospital and Radium Institute in London, where he will work with L. H. Gray.

In explaining the importance of the Hartford Foundation's support of the new research program, Pollard said that biophysics is "the real frontier of science today. The grant will enable biophysics to apply the methods of atomic and nuclear physics to a purely humanitarian and constructive end."

The **George B. Wallace Laboratories of Pharmacology** on the fourth floor of the Medical Science Building of the New York University-Bellevue Medical Center were formally dedicated on 12 Jan. Alfred Newton Richards, emeritus professor of pharmacology at the University of Pennsylvania, delivered the principal address. Richards' association with Wallace began in 1902 during the first of Wallace's 44 yr as head of the N.Y.U. department of pharmacology. A close friendship continued between these two eminent pharmacologists until Wallace's death in 1948.

A new unit for the expansion of medical research through the investigation of problems in microbiology and medicine has been set up in the laboratories of the **Wistar Institute of Anatomy and Biology** under the joint auspices of the institute and the University of Pennsylvania. The new unit is under the direction of Geoffrey W. Rake, research professor of microbiology in medicine at the university and staff member of the institute. Studies are being undertaken in infectious disease processes and the host cell-parasite relationship in man and animals.

The **Samuel Sackett Foundation,** established recently for scientific research, has selected as its first project an investigation of rheumatic fever and its related diseases that will be conducted in the **Northwestern University** medical school. Studies will be supported by income from the $500,000 foundation created by Mr. and Mrs. Samuel J. Sackett of Evanston, Ill., and their daughter, Elizabeth Sackett Crocker, of Houston, Tex. Foundation trustees are Sackett; Frank T. Murray, Chicago attorney, and Lowell D. Snorf, Northwestern University professor of medicine.

Laboratory facilities for the studies will be provided in the new Morton Medical Research Building, scheduled for completion in April at the Northwest-

ern Medical Center on the university's Chicago campus. The project will be directed by a senior investigator, yet to be appointed, within the medical school's department of medicine. A broad and continuing investigation is planned, rather than any specific study related to a limited aspect of rheumatic fever. Thus it is hoped to develop a cohesive and imaginative research program that will furnish a background for specific studies.

The first course ever to be offered in **engineering information sources** and literature will be given by the Columbia University School of Library Service during the regular summer session, 5 July–12 Aug. Tuition and registration fees are $82. Russell Shank, librarian of the Engineering and Physical Science Libraries at Columbia, will teach the course, which will survey and evaluate library resources in engineering and physical sciences. It is designed to meet problems of academic and industrial librarians. It will also discuss methods of obtaining house organs, trade journals, memorandums from industrial corporations, press releases (and how to use them), industrial films and mimeographed documents and reports on government-sponsored research by industry, universities, and government agencies.

Available Fellowships and Awards

The **Society for Psychical Research** (parapsychology) offers a prize of $140 for an essay on a subject that falls within its field. The essay may present original ideas or criticism or describe a recent piece of experimental work, and preferably should not exceed 3000 words. Entrants should submit their essays under a pseudonym, enclosing their name and address in a sealed envelope. Entries should be typed double space on one side of the paper only, and must be *submitted by 30 June 1955* to the Secretary, Society for Psychical Research, 31 Tavistock Sq., London W.C.1.

The **Darbaker Prize Committee** of the Botanical Society of America will accept nominations for an award to be announced at the annual meeting of the society in 1955. Under the terms of the bequest the award is to be made for meritorious work in the study of the algae, particularly the microscopic algae. The committee will base its judgement primarily on the papers published by the candidate during the last two full calendar years previous to the closing date for nominations. Only papers published in the English language will be considered. Nominations for the 1955 award accompanied by a statement of the merits of the case and by reprints of the publications offered as evidence in support of the candidacy should be sent to the chairman of the committee, Wm. Randolph Taylor, Dept. of Botany, University of Michigan, Ann Arbor, Mich., *by 28 Feb.* The value of the prize for 1955 will depend on the income from the trust fund, but is expected to be about $150.

Fellowships and assistantships are now available at the **Baylor University Graduate Research Institute** for students wishing to work toward the M.S. and Ph.D. degrees. The Graduate Research Institute, housed in the newly constructed Wadley Research Institute and Blood Center, is located in Dallas, Tex., on the grounds of the Baylor University Hospital. Degrees are being offered in chemistry, bacteriology, cytology, immunology, and human genetics. Attention is drawn to the unusual opportunity for patient studies. Inquiries and applications should be directed to Dr. J. M. Hill, Baylor University Graduate Research Institute, 3600 Gaston Ave., Dallas, Tex.

Teaching assistantships and graduate fellowships are available in most departments of the **College of Engineering and Science, Carnegie Institute of Technology,** for able graduate students. Normally, the duties assigned entail 9 to 12 hr/wk of laboratory instruction. Assistants are permitted to carry from two-thirds to seven-eighths of a full load of graduate work. The stipend is $1680 per academic year for the first year and $1780 for the second, from which the student must pay his tuition. A few assistantships entailing more work and a correspondingly higher stipend are available.

Several departments and research laboratories employ research personnel for part-time research under the supervision of a member of the staff. Part-time research assistantships carry stipends comparable to teaching assistantships.

Graduate fellowships, supported by outside agencies and special institute funds, carry liberal grants based upon need, in addition to tuition. These fellowships are offered by most departments in the college. They are awarded to outstanding graduate students to permit them to devote full time to advanced study and research. In general, fellowships are not awarded to beginning graduate students.

Applications for admission to graduate study and for assistantships or fellowships, together with transcripts of record and other supporting evidence, should be submitted as early as possible, preferably *not later than 1 Mar. 1955.* However, applications from able and well-qualified candidates will be considered if received at a later date. Address all inquiries to: Dean of Graduate Studies, Carnegie Institute of Technology, Pittsburgh 13, Pa.

The following are the 1955–56 graduate opportunities in **botany at Columbia University.**

Industrial fellowship in plant biochemistry. An industrial fellowship for the study of polyphenolic pigments in plants. R. F. Dawson.

Research assistantship in cytogenetics and cell physiology. An Atomic Energy Commission grant for the study of nucleic acid and nucleoprotein metabolism in cells using radioisotopes and autoradiographs. $1800.

Higgins fellowship in botany. For graduate work in

any field of botany. Approximately $2000. *Applications due 20 Feb.* Forms may be obtained from the Office of Admissions, 322 University Hall, Columbia University, New York 27.

Teaching assistantships in various areas of botany. These have stipends of $1300 with free tuition. General botany (Columbia College), E. B. Matzke; general botany (Barnard College), D. D. Ritchie; microbiology (Barnard College), Helen B. Funk; morphology and cellular morphology, E. B. Matzke; mycology, L. S. Olive; physiology and biochemistry of fungi or higher plants, R. F. Dawson; physiology, S. F. Trelease.

Inquiries, except for the Higgins fellowship, should be addressed to the professor concerned. Fellowships and assistantships for Columbia are also available at the New York Botanical Garden and at the Boyce Thompson Institute for Plant Research.

Grants and Fellowships Awarded

The **Atomic Energy Commission** has announced the award of 34 unclassified physical research contracts, most of which are for 1 yr.

University of California. C. D. Jeffries. Nuclear moments, $10,260.

Florida State University. A. E. S. Green and M. A. Melvin. Analysis of nuclear forces, $6825.

University of Michigan. R. B. Bernstein. Fundamental research on isotopic reactions, $9450.

University of Arizona. E. B. Kurtz, Jr. Uranium accumulation in plants, $5200.

California Institute of Technology. N. Davidson. Complex ions and reaction mechanisms in solution, $12,000.

University of California. J. A. Pask. Mechanics of metal-ceramic bonding, $16,015.

University of California. R. A. James. Nuclear chemistry research, $12,382.

Carnegie Institute of Technology. J. E. Goldman. Research on properties of rare metals, $4500.

Carnegie Institute of Technology. E. Creutz. 400-Mev synchrocyclotron and associated research, $450,000.

Carnegie Institute of Technology. G. Derge. Electrochemical studies of nonaqueous melts, $32,184.

University of Colorado. J. R. Locher and J. D. Park. Thermochemical studies of organic fluorine compounds.

Columbia University. J. M. Miller. Research in radiochemistry, $19,728.

Columbia University. T. I. Taylor. Separation of isotopes by chemical exchange, $23,500.

University of Florida. G. B. Butler and A. H. Gropp. Studies in the preparation and properties of quaternary ammonium ion exchange resins, $10,800.

Illinois Institute of Technology. T. J. Neubert. Investigation of imperfections in solids, $7000.

University of Illinois. F. Seitz and D. Lazarus. Studies on the mechanism of substitutional diffusion in metals, $23,743.

State University of Iowa. L. Eyring. Preparation of rare earth oxides, $10,000.

Massachusetts Institute of Technology. B. E. Warren. Radiation damage in materials, $13,000.

Massachusetts Institute of Technology. G. R. Harrison. Echelle spectroscopy, $7500.

Massachusetts Institute of Technology. P. M. Hurley. Investigations of isotopic abundances of strontium, calcium, and argon in certain minerals, $32,210.

University of Michigan. P. J. Elving. Polarographic behavior of organic compounds, $8964.

University of Pennsylvania. K. R. Atkins. Three experiments on liquid helium, $4994.

University of Pittsburgh. R. Levine. Synthesis of β-diketones and β-ketoesters with heterocyclic nuclei, $8833.

Purdue Research Foundation. H. C. Brown. Chemistry of polyvalent metal halides, $14,400.

Massachusetts Institute of Technology. F. H. Norton and W. D. Kingery. Measurement of thermal conductivity of refractories, $34,420.

Rutgers University. E. R. Allen. Polar inorganic molecules, $10,984.

University of Southern California. H. L. Friedman. Solutions of inorganic electrolytes in solvents of low dielectric constants, $10,100.

Syracuse University. L. Gordon. Coprecipitation studies, $12,500.

University of Texas. E. F. Gloyna. Effects of biological slimes on sea water, $9990.

University of Texas. G. W. Watt. Unusual oxidation states of transitional elements, $18,000.

University of Utah. A. L. Wahrhaftig. Ionization and dissociation of molecules by electron bombardment, $10,780.

Washington University. J. W. Kennedy. Generation of high voltages by means of nuclear radiation, $14,500.

University of Wichita. L. L. Lyon. The permeability method for determining surface areas of finely divided materials, $15,300.

University of Wisconsin. J. R. Dillinger. Low temperature research, $8500.

The **Damon Runyon Memorial Fund for Cancer Research** allocated $60,200 in December.

Sloan-Kettering Institute. R. C. Mellors and O. H. Pearson. Two research projects, $16,000, second year.

New York Academy of Sciences. To support two conferences, Cytology and Cytochemistry, and Oncology, $15,000.

Cancer Institute, Miami, Florida. T. C. Gould and S. A. Gunn. Project, $6000.

Hahnemann Medical College, Philadelphia, Pa. E. C. Bernstorf. Project, $6000.

Johns Hopkins University. F. W. Barnes. Project, $3000.

George Washington University. P. K. Smith. The Metabolism of radioisotope labeled chemotherapeutic agents in cancer, $5800, sixth year.

Immaculata College. S. M. St. Agatha Suter. The cell components of normal and malignant tissues, $2400.

Tufts College of Medicine. Finance a fellowship for W. D. Slingerland, $5400.

The following **AAAS research grants** have been awarded:

Texas Academy of Science to R. J. Baldauf, A. & M. College of Texas. Contributions to the Cranial Morphology of North American Bufonidae (Amphibia, Anura).

Kentucky Academy of Science to O. J. Stewart, University of Kentucky. Study of the homing instinct in pigeons.

Nebraska Academy of Sciences to R. L. Threet, University of Nebraska. Simplified techniques of lighting and copying colored maps and diagrams with 25mm kodachrome.

The Foreign Operations Administration has extended its **program for foreign research scientists**, formerly restricted to 150 candidates, to a total of 185. This program will be administered by the National Academy of Sciences under the same conditions as those that governed the previous program. The European academies have been asked to present applicants as before for review and subsequent placement in American laboratories. These applications may be expected to arrive early in 1955. A list of the most recent awards under this program follows:

From Belgium

Daniel Bermane, electrochemistry—Massachusetts Institute of Technology, with H. H. Uhlig.

From France

Michel Angot, oceanography—Scripps Institution of Oceanography, with Roger Revelle.

Ewald Gondolf, physics—Carnegie Institute of Technology, with Robert F. Mehl.

Christian Wagner, physics—Massachusetts Institute of Technology, with B. E. Warren.

From Germany

Walter Braun, pharmacology—University of Cincinnati, with William D. Lotspeich.

Clemens-August Hackethal, physiological chemistry — The Boston Dispensary of the New England Medical Center, with Gerhard Schmidt.

Walter Harm, genetics—California Institute of Technology, with Max Delbrück.

Lothar Jaenicke, biochemistry—Western Reserve University, with G. Robert Breenberg.

Erich Kessler, plant physiology—University of Chicago, with Hans Gaffron.

Wolfram Keup, biochemistry—New York State Psychiatric Institute, with Heinrich Waelsch.

Martin Klingenberg, biochemistry — University of Pennsylvania, with Britton Chance.

Rüdiger Knapp, botany—California Institute of Technology, with F. W. Went.

Erwin Kreyszig, mathematics — Stanford University, with Stefan Bergman.

Klaus J. Müller, paleontology — State University of Iowa, with A. K. Miller.

Wolfgang Trautwein, physiology — Johns Hopkins Medical School, with Stephen Kuffler.

Gustav Weber, nuclear physics—California Institute of Technology, with Charles H. Lauritsen.

From Italy

Dino Dini, jet propulsion and rockets—California Institute of Technology, with H. S. Tsien.

Giovanni de Franciscis, animal husbandry—Agricultural and Mechanical College of Texas, with H. O. Kunkel.

Alberto Girelli, petroleum chemistry—Bureau of Mines, U.S. Department of the Interior, with John S. Ball.

From Portugal

Pedro Braumann, mathematics — Stanford University, with M. A. Girshick.

José Cardoso, soil genesis—Iowa State College, with Frank F. Riecken.

Antonio da Costa, fisheries—School of Fisheries, University of Washington.

Ramiro Ferrão, animal feeding and meat technology—Agricultural and Mechanical College of Texas, with J. C. Miller.

Antonio Montano, veterinary pathology—Agricultural and Mechanical College of Texas, with Hilton A. Smith.

José Pinto Peixoto, meteorology—Massachusetts Institute of Technology, with H. G. Houghton.

From the United Kingdom

Geoffrey V. Chester, physics—Yale University, with John G. Kirkwood.

Richard Gibbons, biochemistry—Ohio State University, with M. L. Wolfrom.

Charles G. James, physical chemistry—University of California, Berkeley, with Leo Brewer.

Ian M. Mills, infrared spectroscopy—University of Minnesota, with Bryce Crawford, Jr.

Gordon Squires, physics—Institute for Advanced Study, with Robert Oppenheimer, and University of Chicago, with John and Leona Marshall.

Miscellaneous

A list of references on the general subject of **the preservation of living cells** by freezing in glycerine solutions has been compiled by the Glycerine Producers' Association. Three main aspects of the subject are covered: blood cell preservation, sperm cell preservation, and tissue preservation. The references cite articles published in, as well as individuals and publications concerned with, the field. Copies of the list may be obtained from the Glycerine Producers' Association, 295 Madison Ave., New York.

Science as a social and historical phenomenon is the central theme of the following four articles in the February issue of ***The Scientific Monthly***: "Some aspects of science during the French Revolution" by Henry Guerlac; "Dual role of the Zeitgeist in scientific creativity" by Edwin G. Boring; "Influence of philosophic trends on the formation of scientific theories" by Alexandre Koyré; and "Alternative interpretations of the history of science" by Robert S. Cohen. These articles are based on papers that comprised the last part of a symposium held in Boston, 27–30 Dec. 1954, on the general subject *Validation of Scientific Theories*. The papers in the other four sessions appeared in preceding issues.

The other articles that appear in this issue include "The United Nations in perspective" by John B. Whitton *et al*; "Sperm maturesence" by David W. Bishop; "Philippine hydroelectric development" by Wallace E. McIntyre; and "Why science attachés?" by Robert L. Loftness. "Atoms for export" is the picture story in the "Science on the march" section, and it deals with the improved facilities at the British Radiochemical Center at Amersham, near London. There are 16 book reviews in this issue.

March 1955 is the scheduled release date for the **first issue of *Forest Science***, an international journal of research and technical progress in forestry. The journal will appear quarterly under the auspices of the Society of American Foresters and will feature articles of interest to research, teaching, and administrative personnel in the field of forestry.

A grant of $2000 from the Horace H. Rackham fund of the University of Michigan has been set aside for the initial publication of the journal. The three-man board of editors consists of Henry Clepper, executive secretary of the Society of American Foresters; V. L. Harper, assistant chief, Forest Service, USDA; and Stephen H. Spurr, professor of silviculture at the University of Michigan. For information concerning subscriptions or manuscripts, write to Stephen H. Spurr, School of Natural Resources, University of Michigan, Ann Arbor.

Notice is hereby given that, *beginning 30 June 1955*, the **International Commission on Zoological Nomenclature** will start to vote on the following cases involving the possible use of the plenary powers for the purpose specified against each entry. Full particulars of these cases were published on 30 Dec. in parts 10 and 11 of vol. 9 of the *Bulletin of Zoological Nomenclature*. (i) *Dama* Frisch, 1775 (cl. Mammalia), validation of, for use for the name for the Fallow Deer of Europe; (ii) *Helicella* Férussac, 1821 (cl. Gastropoda), validation of; (iii) *rufa* Linnaeus, 1761 (*Formica*), validation of, and designation as type species of *Formica* Linnaeus, 1758 (cl. Insecta, order Hymenoptera); (iv) *Carinifex* Binney, 1865 (cl. Gastropoda), validation of; (v) *Discias* Rathbun, 1902, *Upogebia* Leach, 1814, *Processa* Leach, 1815, XANTHINAE Dana, 1851, UPOGEBIINAE Borradaile, 1903, and PROCESSIDAE Ortmann, 1896 (cl. Crustacea, order Decapoda), validation of.

Comments on the afore-mentioned cases should be sent as soon as possible to Francis Hemming, secretary to the commission, 28, Park Village East, Regent's Park, London, N.W. 1.

Book Reviews

Aetiologie und Prophylaxe des Lungenkrebses als ein Problem der Gewerbehygiene und des Tabakrauches. Fritz Lickint. Steinkopff, Dresden, 1953. 212 pp. Illus. (Beiträge zur Krebsforschung ed. 2.)

This book closes with a plea for criticisms and suggestions from those interested in lung cancer, emphasizing the desirability "for objectivity in order to help the cause, rather than to do damage." Nevertheless, Lickint has written a very subjective and even passionate book, culminating in the statement that "there can be no doubt that the most promising preventive measures for cancer of the lung may be expected in the field of tobacco consumption."

In spite of Lickint's biased attitude, this book may be useful to those working in the etiology of cancer of the lung because it offers a wealth of bibliographic material not usually considered in American studies. There are some 1500 references, the majority to European sources, with a fair coverage of the Anglo-Saxon literature.

The book is divided into three main chapters: a general one dealing with statistical, ethnological, and geographic medical considerations; a "special" portion considering the etiology, which is divided into sections of infectious diseases, chemical causes, physical causes, and tobacco as a cause of lung cancer; and a final chapter dealing with prevention of cancer.

The critical reader will discard many of the arguments that tend to minimize all possible etiologic factors except tobacco. Lickint complains bitterly about the "nonsensical objections and entirely unproven assumptions" which form an "underbrush rendering further work so difficult," but he does not hesitate simply to overlook such facts as may be contrary to his preconceived idea that tobacco, particularly cigarettes, definitely causes lung cancer. In the general discussion of carcinogenesis there are some critical omissions, such as the failure to consider Sugiura's studies on carcinogenic oil derivatives, Berenblum's work on cocarcinogens, and even Potts' classical observations on soot in chimney sweeps.

The fact that Norway and Cuba are exceptions to the rule that cancer of the lung occurs with higher incidence in men than in women is simply explained away. Many inaccurate and confused statements, although not representative of the book as a whole, reflect the poor quality of its scholarship.

Nevertheless, as a source of material, particularly for the older foreign work on the subject of cancer of the lung, this book has value. It relates the interesting geographic medical observations that in Russia cancer of the lung increased in frequency even before 1900, and that in recent years it has no longer increased in the Soviet Union. It provides equally interesting observations on the epidemiology of lung cancer in Turkey before and after the introduction of cigarettes into that country.

In the chapter on experimental production of cancer with tobacco products there is a wealth of older material, largely listed without critical evaluation. Nevertheless it is presented, whereas there is a tendency in the newer American literature to omit this older material altogether.

One wonders why the furore about cigarettes and cancer has started only recently when, as appears from Lickint's book, so much information on the subject has long been available, and when alarming rises in cancer of the lung have taken place for as long a period of time as seems to have been the case.

This book, with all its shortcomings, can be helpful in providing the background information for many who are interested in studying the lung cancer problem. Because of its speculative and biased reasoning, however, it does little to clarify the question of the etiology of lung cancer. It merely obscures the issues still further with a dense screen of cigarette smoke.

The geographic location of the author may have made it wise for him to close with a quotation from I. P. Pavlov; but there is irony in his doing so because his book reads like the reaction of one who has developed a conditioned reflex against anything connected with tobacco.

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Information Theory. Stanford Goldman, Prentice-Hall, New York, 1953. 385 pp. Illus. $9.

The growing importance and vitality of information theory is amply witnessed by the appearance of this graduate-level engineering textbook. Its nine chapters begin with a chapter on information theory of discrete (spelled "discreet" throughout) systems, followed by three chapters on properties of continuous signals, ergodic ensembles and random noise, and the entropy of continuous distributions, which lay the groundwork for the next chapter on transmission of information in band-limited systems having a continuous range of values. After a short chapter on "signal space," introducing some elementary but useful concepts from the geometry of spaces of n dimensions, there are two chapters on information theoretical aspects of modulation and noise reduction and on linear correlation, filtering, and prediction. The final chapter, on divers aspects of information, is on an almost popular level. Thirteen appendixes, 11 devoted to various mathematical developments, one to solutions of some of the book's numerous problems, and one to a table of logarithms to the base 2, conclude the book.

The mathematical level should not be difficult for the average first-year graduate engineering student. Some familiarity with complex variables and Fourier methods is assumed, but the rudiments of prob-

ability, statistics, stochastic variables, ergodic ensembles, and so forth, are developed as needed. In my opinion, the book would gain much by including a more complete and precise treatment of these concepts, so important, for example, in problems involving noise. It would also seem desirable to include more in the way of application to problems of system design in which the methods of information theory are advantageous. The student who finishes the book may wonder to some extent what the fuss is all about. Error-detecting codes, theory of radar information, and telephone traffic problems, to name but three possibilities, could provide such examples and balance the almost unrelieved mathematical and theoretical flavor of the treatment.

In spite of this, the textbook succeeds fairly well in bridging the gap between beginning graduate level on the one hand, and the work of Wiener, Shannon, and current research on the other.

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The Energetics of Development. A study of metabolism in the frog egg. Lester G. Barth and Lucena J. Barth. Columbia Univ. Press, New York, 1954. xviii + 117 pp. Illus. $3.

In the preface to this book, the authors frankly admit that, in spite of the wealth of experimental results in the physiological embryology of the frog, we still lack certain unifying concepts that are necessary for an understanding of the direct coupling between energetics and differentiation. They then proceed with a review of recent studies (mostly those appearing after 1949) of the mechanisms by which the energy of the frog's egg is stored, released, and transferred during early development.

In the introductory chapter, the authors discuss some of the problems of tracing the chain of reactions from the stored energy-rich compounds to the final acceptors of energy within the differentiating cells. They recognize the possibility that some developmental processes, such as the determination (differentiation) of various cell types, may or may not depend upon energy-producing reactions, and that the whole problem of the energetics of development might have to be shifted back to the developing oöcyte in which protein synthesis is occurring. However, there is a possibility (which the Barths no doubt realize but do not discuss) that, even if we are able to pinpoint the detailed pathway by which the energy required for a particular differentiation process is derived, we may still be a long way from understanding the mechanism of the differentiation process itself. It seems unlikely, at least in my opinion, that the energetics of development could be importantly different from the energetics of cells in general. Whether identification of the final coupling reactions between the energy-furnishing machinery of the cell and one of its developmental processes would bring us closer to an understanding of the significant causal features of the process also seems doubtful. It would appear that the energetics of a developing organism is best thought of as an adjunct to, rather than as an integral part of, the various developmental processes. Perhaps in time we shall know whether such a point of view was justified or was merely flippant.

The second, third, and fourth chapters deal, respectively, with the storage of energy in the frog oöcyte, the release of energy during development, and the metabolism of gastrula parts. The evaluation of studies in these areas is rather critical, and the frankness with which the many problems are faced is commendable. For example, in their discussion of the respiratory metabolism of different gastrula parts, the authors come to the tentative conclusion that the modes of energy release in these developmentally very different regions of the egg are identical, and that it is in the utilization of energy that a possible mechanism for correlating metabolism with development (for example, cellular differentiation) is to be sought. They recognize (p. 64) ". . . that fundamental differences [other than respiratory] pre-exist in different cells; otherwise we cannot obtain differentiation from an equipotential system."

In the fifth and final chapter, the Barths discuss recent studies on the protein metabolism of the frog's egg, based largely on their own unpublished researches. About one-third of the book is devoted to a detailed presentation of evidence for the relationship of various extractable yolk proteins to phosphate metabolism. The authors tentatively conclude that (p. 105)

> . . . ATP may not act as a direct intermediary in the transfer of phosphate from phosphoprotein [yolk] donor to acceptor, but rather that its function may reside in a control of the amount and locus of phosphoprotein breakdown.

NELSON T. SPRATT, JR.

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New Fibres from Proteins. Robert Louis Wormell. Academic Press, New York; Butterworths, London, 1954. xx + 208 pp. Illus. $5.80.

Robert Louis Wormell has spent many years in the study and development of protein fibers in the Courtaulds organization, and one of the principal objectives of his book is to present many of the facts gathered during this experience. A second objective is to clarify existing data and to correlate it with related fields. A third purpose is to advance a new concept of protein fiber structure ("the corpuscular theory"), which pictures a protein molecule as composed of a number of polypeptide chains converging at the center of a corpuscle, rather like a dandelion flower. The book is quite broad in its coverage, including, for example, raw materials, protein denaturation and structure, general principles of protein fiber production, swelling and other physical properties of

protein fibers, dyeing and finishing of regenerated protein fibers, identification of fibers from proteins, uses of fibers from proteins, and so forth.

This book should be most useful for its presentation of accumulated data, taken by Wormell from his own works and the general literature. The material on spin dopes, extrusion of fibers, cross-linking treatments, and physical and chemical properties should be very helpful to scientists and technologists interested in protein fibers, as well as many students of man-made fibers in general.

I found the "corpuscular theory" far from convincing, especially when applied to a fiber such as silk. The emphasis on this theory may actually be confusing to a person unfamiliar with protein fibers, but on the whole the book is a useful compilation that will be helpful to workers in the field.

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Sex in Microorganisms. A symposium presented 30 Dec. 1951 at the Philadelphia meeting of the AAAS. D. H. Wenrich, Ivey F. Lewis, and John R. Raper, Eds. AAAS, Washington 5, 1954. 362 pp. Illus. $5.75 (Members, $5).

Sex in Microorganisms is broadly conceived to include anything related to the reproductive cycles of protozoa, algae, fungi, bacteria, and viruses. The subtitle to the volume is unnecessarily restrictive, since many topics are not only presented in greater detail than was possible at the Philadelphia meeting, but they are also more up-to-date than is implied. There is at least one 1953 reference in each article. As is to be expected in a symposium, there is considerable variation in the manner in which the different subjects are treated by the different authors. The papers themselves range in length from 11 pages (bacteriophages) to 132 pages (protozoa).

The volume opens with a brief and clear outline by N. Visconti of the life history, methods of crossing, and genetic observations of the virulent T-phages of *Escherichia coli,* with emphasis on important dissimilarities to equivalent genetic phenomena as known in higher organisms. The sexual behavior of bacteria, as inferred from genetic recombination in strain K-12 of *E. coli,* is discussed by J. Lederberg and E. L. Tatum in a somewhat reminiscent mood. Here the principal emphasis is on similarities to genetic events in higher organisms. Possible relationships to bacterial transformation and transduction are mentioned, but in a manner that seems to imply that little is known of transformations, and that only since 1951. W. G. Hutchinson and H. Stempen discuss the evidence for sexuality in bacteria from studies of morphology, especially from reported examples of conjugation, and they remark on the unsatisfactory present state of bacterial cytology. The diverse life cycles and sexual mechanisms found in the fungi are reviewed by J. R. Raper, and classified according to (i) the occurrence and extent of haploid, dicaryotic, and diploid, phases, (ii) the type and degree of heterothallism, and (iii) the type of cell, or organ, taking part in conjugation. The types of reproduction occurring among the diatoms are reviewed by Ruth Patrick. The topic of sex in unicellular algae, by R. A. Lewin, relates chiefly to *Chlamydomonas,* includes discussions of physiological aspects of reproductive processes, and emphasizes the differences in experimental results obtained by Moewus and all other investigators. In the longest paper, and the only one extensively illustrated, D. H. Wenrich presents a comparative review of the reproduction cycles occurring among the natural groups of protozoa. Mating-type determination in *Paramecium aurelia* is discussed by D. L. Nanney in relation to the parts played by macronucleus, micro-nuclei, and cytoplasm. There is a rather extensive review by C. B. Metz of the physiology of fertilization in *Paramecium* and of the mating substances involved, with references to studies on other ciliates and a comparison with metazoan fertilization. The volume ends with comments by D. H. Wenrich on the origin and evolution of "sex," in which he discusses several postulated reasons why sexual reproduction is beneficial to organisms, omitting that which seems most important to geneticists, namely, that it constitutes the basis for the recombination of genetic traits possessed by individuals.

The audience for which this book is intended is not immediately apparent. While it gives a general survey of the diverse sexual mechanisms occurring among the microorganisms, the coverage is, in some respects, less thorough than in earlier compendiums on the same subject. New and exciting discoveries, not reviewed in older works, are limited principally to the implications of sexuality in viruses and bacteria and to details of the mating reactions in the ciliates.

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The Human Masticatory Apparatus. An introduction to dental anthropology. Meyer Klatsky and Robert L. Fisher. Dental Items of Interest Publ., Brooklyn; Henry Kimpton, London, 1953. xxi + 246 pp. Illus. $6.

Increasingly, dentistry is refuting bygone appellations such as "dental mechanic," "tooth carpenter," and the like. On the contrary, it is emergent as a science and as a healing art, closely integrated with related sciences (such as paleontology, both comparative and human, descriptive morphology, physical anthropology, and genetics) and with the sister healing art of medicine. Time-honored scientific and clinical fences have given way to common grazing grounds.

This volume is a record of the changing perspectives in dentistry, that is, that teeth are more than mere structure and that they have a functional aspect related to other bodily systems. This integrative perspective carries with it a time element, namely, that the

human dentition is best understood in terms of its evolutionary background. Hence, the book's first chapter is given over to "evolution and dental degeneration." Here are pointed organic origins and trend, with emphasis upon present involutionary trends, leading (by inference) to various kinds of structural and functional disuse atrophy.

Such a trend may be recognized today in two major fields: first, consolidation in racial dento-facial patterns; second, entrenchment in unit characters or trait-complexes, genetically speaking, in face and teeth. These fields are covered, although of necessity the racial data are simplified in the sense of bypassing moot or obscure points of detail.

For present consideration the authors stress the dynamics of functional integrity. The discussion of "diet and its effect upon the masticatory apparatus" is focused upon the problem that primitive diets—"rough, bulky, and resistant"—conduced to dental health and vigor, while modern diets—"refined texture of the food, and the sophisticated methods of its preparation and consumption"—lead to poor tissue and muscle tonus, incorrect tooth-bone relationship, and rotten teeth. It must be noted however, that claims of this nature are, in this book, stated rather than demonstrated or proved.

There are very useful genetic chapters on "The relation of genetics to dental science," on "dental anomalies," and on "the future of our third molar." Many traits of teeth and jaws are discussed in genetic terms. Perhaps the most far-reaching discussion is that of "dentistry as a public health service," for the authors feel that "the health and welfare of the human masticatory apparatus . . . is a public health problem which must be solved by united effort."

This book, I feel, is a useful contribution toward such a goal.

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Structure Reports for 1945–46. vol. 10. A. J. C. Wilson, Gen. Ed.; C. S. Barrett (Metals), J. M. Bijvoet (Inorganic compounds), and J. Monteath Robertson (Organic compounds), Section Eds. Utrecht: Oosthoek, 1953. (For the International Union of Crystallography.) 325 pp. Illus. $12.

This volume follows the pattern and maintains the standard of volumes 11 and 12. It is divided into three sections: "Metals," "Inorganic compounds," and "Organic compounds." In the introduction the general editor says:

> Structure Reports are not intended to be abstracts in the ordinary sense. Ideally they extract only material of structural interest . . . so completely that no further structural information would be gained by consulting the paper itself,

This aim has been achieved, in general, and, in some cases, critical comments added by the reporters as well as derivative information computed from the original data make the report even more useful than the original paper. The difficult problem of classification, particularly in the sections dealing with inorganic and organic compounds, has been neatly sidestepped by placing these substances roughly in order of increasing complexity and by providing excellent author, subject, and formula indexes.

The considerable number of papers which are reported from behind the Iron Curtain and from Japan make this invaluable to the crystallographer who is remote from the larger libraries and whose command of the Russian and Japanese languages is either very elementary or, more probably, nonexistent. The type is clear and the diagrams are excellent. Although the paper used is thick and of good color, it soils quickly with use. It seems a pity that a higher gloss paper was not selected for this publication that undoubtedly will be frequently consulted for many years to come.

Crystallographers and all others who are interested in the structures of elements and compounds, whether they are chemists, metallurgists, physicists, or natural scientists owe a considerable debt of gratitude to the International Union of Crystallography who conceived the plan for *Structure Reports* and to A. J. C. Wilson, his section editors, and reporters for the careful, exhaustive, and accurate execution of their task. When the gap between volume 10 and the last volume of *Strukturbericht* is finally closed there will be available, in a most convenient collection, an almost complete record of structural investigations from the birth of x-ray diffraction studies to the present time.

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New Books

Relativity for the Layman. A simplified account of the history, theory, and proofs of relativity. James A. Coleman. William-Frederick, New York, 1954. 131 pp. $2.75.

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Intelligent Layman's Medical Dictionary. Harry Swartz, Frederick Ungar, New York, 1955. 306 pp. $4.75.

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Technical Papers

Isotopic Composition of Bromine in Nature

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Relatively few of the chemical elements have been investigated by precision mass spectrometry in the search for variations in isotopic composition in nature. In general only the light elements have been so investigated. The approximately equal abundance of the two bromine isotopes makes precision ratio measurement easier and in addition the sublimation of sodium bromide in a source adapted for solid sample handling eliminates any question of fractionation in a gas handling system.

Elemental bromine for this investigation (*1, 2*) was obtained from four suppliers. Searles Lake bromine, produced by the American Potash Corp., Los Angeles, Calif., is believed to be in large part of volcanic origin. Bromine from Michigan salt brines (Dow Chemical Co., Midland, Mich.) and from West Virginia brines (Westvaco Chemical Div., Food Machinery and Chemical Corp., New York) is considered to be representative of the bromine in Silurian sea water approximately 350×10^6 yr ago. Bromine from Pacific Ocean water was produced by the Westvaco Chemical Div. from salt bitterns at Newark, Calif. The Dow-Ethyl Corp. produces bromine from Gulf water at Freeport, Tex., but does not market it. A sample of ethylene dibromide from this origin was obtained from F. N. Holmes of the Ethyl Corp. Laboratory in Baton Rouge, La.

Portions of the elemental bromine samples were reacted with an excess of ammonium hydroxide in an ice bath, evaporated to dryness, redissolved, and then the calculated amount of sodium hydroxide was added to convert to sodium bromide. The ethylene bromide sample was refluxed in acetone solution with a small excess of sodium iodide. The bromide recovered was contaminated with some sodium iodide. Every attempt was made to secure complete recovery and to avoid possibility of fractionation by partial crystallization. Small rolls of fine nickel screen or fragments of porous Alundum were impregnated with a concentrated aqueous solution of sodium bromide, oven dried and then vacuum dried. These samples were installed in an ion source specifically developed for handling solid samples (*3*).

Measurements were made with two 60° sector spectrometers of 15-cm radius; the bromide vapor was ionized by 75-ev electrons, and 1900-v acceleration potential was used. The ion beams were brought alternately upon the collector by magnetic field scanning. The voltage developed in the input resistor of the FP-54 electrometer was balanced by voltage from a precision decade potentiometer, residual galvanometer deflections being converted into potentiometer readings by interpolation factors determined experimentally. For each ratio reported in Table 1 at least 10 ratio measurements were made. The precisions are stated for each set of data at the 95-percent confidence level. In general two sets of data were taken on each sample some hours apart to verify that no shift with time occurred. Measurements were made over a period of some months whenever instrument time was available.

No significant difference appears to exist among these samples. In addition, there is excellent agreement between the grand average of these determinations and the ratio determined by Williams and Yuster (*4*), which is the value accepted for this ratio by Bainbridge and Nier (*5*):

	Br^{79}/Br^{81}
This measurement	1.0217 ± 0.0002
Williams and Yuster	$1.0210 \pm .0020$

Bromine derived from Dead Sea brine was not available, but might be interesting to investigate, particularly since there is speculation that it may originate from beds of purple snail fossils. No sample of bromine-bearing mineral has been examined. These are rather rare, the silver halide ores probably being the best source.

Table 1. Bromine isotopic ratio in samples of known origin.

Sample origin	$NaBr^{79}/NaBr^{81}$	Average
Michigan brines	1.0222 ± 0.0030	
	$1.0256 \pm .0009$	
	$1.0242 \pm .0002$	
	$1.0204 \pm .0007$	
		1.0231 ± 0.0040
Searles Lake	$1.0256 \pm .0020$	
	$1.0241 \pm .0005$	
	$1.0223 \pm .0005$	
	$1.0204 \pm .0006$	
	$1.0200 \pm .0001$	
		$1.0224 \pm .0062$
Pacific Ocean	$1.0202 \pm .0010$	
	$1.0248 \pm .0009$	
	$1.0207 \pm .0007$	
	$1.0160 \pm .0001$	
	$1.0204 \pm .0062$	
	$1.0174 \pm .0031$	
		$1.0214 \pm .0043$
West Virginia brines	$1.0194 \pm .0014$	
	$1.0207 \pm .0007$	
	$1.0205 \pm .0007$	
		$1.0202 \pm .0016$
Gulf water (ethylene dibromide)	$1.0226 \pm .0018$	
	$1.0188 \pm .0025$	
	$1.0205 \pm .0012$	
		$1.0206 \pm .0040$

References and Notes

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1. This article is based on work performed for the U.S. Atomic Energy Commission by the Carbide and Carbon Chemicals Co., a division of Union Carbide and Carbon Corp., at Oak Ridge, Tenn.
2. The recommendations of Ralph Cannon of the U.S. Geological Survey were followed in selecting the samples.
3. A. E. Cameron, "Electron bombardment ion source for mass spectrometry of solids," *Rev. Sci. Instr.*, in press.
4. D. Williams and P. Yuster, *Phys. Rev.* 69, 556 (1946).
5. K. T. Bainbridge and A. O. Nier, "Relative isotopic abundances of the elements," Preliminary Rept. No. 9, Nuclear Science Series, National Research Council, (NP-1971).

9 September 1954.

Territorialism in Two Species of Salamanders

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Among the vertebrates it is well known that certain activities of individuals of a species may be limited to more or less roughly defined areas or home ranges. Territories may be established in the defense of such areas or portions thereof. Relatively little information is available on the home ranges and territories of the poikilothermal tetrapods. Examples of investigations that have yielded meaningful results are those of Nichols (*1*) on the home range of the box turtle, *Terrapene carolina* and Evans (*2*) on territorial defense in *Anolis sagrei*, the Cuban lizard. The display of aggressive territoriality in the South American frog, *Phyllobates trinitatis* has recently been described by Test (*3*). Aggressiveness was most pronounced in adult females in the defense of their home sites and feeding grounds.

In the urodeles, females of several species are customarily found on or near the developing egg masses. Such a situation has been thoroughly described by Wood (*4*) in the four-toed salamander, *Hemidactylium scutatum*. His investigations seem to indicate that this is not a case of territorialism per se, for the majority of the females present at nesting sites are gravid, having congregated for the purpose of laying eggs rather than maintaining a vigil over them.

This paper reports preliminary studies of territorialism in *Hemidactylium scutatum* and the two-lined salamander *Eurycea bislineata*. Studies were conducted in aquariums provided with a terrain of moss and forest debris in order to simulate the natural habitat of the animals. Each habitat thus established occupied an area 18 by 9 in. In the first experiment four specimens of *E. bislineata* were introduced into this environment. Two individuals immediately selected stations under bark fragments at opposite ends of the area. After a period of several weeks it became apparent that these were permanent stations and it was possible to plot a home range for each individual. This extended for a radius of 5 to 6 in. from the centrally located shelter site except where limited by the walls of the chamber. Repeated experiments, in which as many as six individuals were used, showed that the laboratory habitats described above would support no more than two resident individuals at a time. In almost every case there was a slight overlapping of the home ranges. Although food was supplied throughout the environment, established individuals were observed eating outside their home area on only two occasions. It is reasonable to assume that in this species the home range corresponds roughly to the general feeding grounds.

Animals that did not occupy home ranges wandered at random. When an errant individual entered the home range of another member of its species, it was allowed to approch within 2 in. of the shelter site. At this point the resident advanced and placed its snout in direct contact with that of the intruder. After the antagonists had remained in this posiiton for several minutes, the intruder always backed away from the area and continued its course in a different direction. Such intimidation of the intruder was the usual method of defense displayed by *E. bislineata*. On occasion, however, this technique was abandoned in favor of direct assault, in which the intruder was bitten about the snout or tail, not infrequently losing large portions of the latter member during the foray. These investigations indicate that the actual territory of *E. bislineata* is limited to a region in the immediate vicinity of the shelter site. The undefended portions of the home range cover a considerably larger area.

The number and composition of the home ranges established by *H. scutatum* corresponded closely to those of *E. bislineata*. However, territorialism was not as aggressively maintained as in the two-lined salamander. Intimidation was the only method of defense observed. An intruder usually halted as a resident advanced toward it from the shelter site. Although there was seldom any direct contact between the two animals, the mere presence of the resident seemed to be sufficient intimidation to cause the intruder to withdraw. Intruders were occasionally allowed to pass unmolested over shelter sites. However, since two animals never occupied the same shelter and since no resident was ever evicted from his established domain, it is reasonable to conclude that in *H. scutatum* the integrity of the territory is maintained, although aggressive territorialism is but weakly developed. It is interesting to note that specimens of *H. scutatum* and *E. bislineata* that did not establish a home range consistently refused to accept food under any conditions and eventually starved to death.

Territorialism has been observed in *E. bislineata* and *H. scutatum* kept in the laboratory. In both species the integrity of the shelter site is maintained and a territory thus defined. However, it should be noted that in nature the home ranges and territories of these species can be expected to vary greatly in size and shape according to the available food supply, population density, terrain, and so forth. The selective advantage afforded individuals possessing a sheltered territory is obvious, for animals deprived of such a

retreat must sustain heavy predation. Furthermore there is some evidence that the proper feeding reactions of an individual are dependent on its possession of a home range and associated shelter site. Much additional work is called for in the study of territorialism in the amphibians. It would be particularly interesting to determine what specific reactions are involved in a defense by intimidation when there is little or no display apparent.

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On the Conversion of Anthranilic Acid to Indole

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Isotope studies on the utilization of anthranilic acid as a precursor of tryptophan in *Neurospora* have indicated that during the conversion of anthranilic acid to indole the carboxyl group is lost (*1*) and the amino group is retained (*2*). Somewhat different conclusions concerning indole synthesis in *Escherichia coli* have been arrived at by Bergmann *et al.* (*3*) on the basis of inhibition analyses. These workers suggest that in *E. coli* the carboxyl carbon of anthranilic acid is retained during conversion to indole.

The question of whether or not the carboxyl carbon of anthranilic acid is lost in *E. coli* has recently been examined in tracer experiments performed with this organism. The results obtained (*4*) showed conclusively that in *E. coli*, as in *Neurospora*, the carboxyl group of anthranilic acid is removed during the formation of indole. In the synthesis of indole from anthranilic acid, therefore, two carbon atoms must be added to form the pyrrole ring of indole. Since the carboxyl group of anthranilic acid is removed during this process, the pyrrole ring of indole could be formed through either the 1- or the 3-position of the benzene ring of anthranilic acid. The results of an experiment designed to distinguish between these possibilities are presented in this paper (*5*).

Washed cell suspensions of certain tryptophan auxotrophs of *E. coli* readily convert anthranilic acid to indole, and cell-free extracts of such cells also carry out this conversion (*4*). 4-Methylanthranilic acid can be substituted for anthranilic acid, in which case a methylindole is formed. If ring formation in the production of methylindole from 4-methylanthranilic acid occurred through the 1-position of the benzene ring, the product of the reaction should be 6-methylindole (Fig. 1). If, however, the pyrrole ring is formed through the 3-position, 4-methylindole should result. If the ring could be formed through either position, as, for example, if aniline were the product of anthranilic acid decarboxylation, then a mixture of 4- and 6-methylindole might be produced. Thus identification of the methylindole formed from 4-methylanthranilic acid would permit distinguishing between the various possibilities.

Washed cell suspensions of a tryptophan auxotroph of *E. coli* were incubated (with shaking) in the presence of 4-methylanthranilic acid (40 μg/ml), glucose (2mg/ml) and hydroxylamine hydrochloride (200 μg/ml) (*6*). After a 30-min incubation period at 37°C an additional portion of hydroxylamine hydrochloride (200 μg/ml) was added. After 60 min, incubation was stopped and the cells were removed by centrifugation. A few milliliters of alkali were added to the supernatant solution (enough to make it slightly alkaline), which was then extracted with several portions of ether. The ether extracts were combined and concentrated to a few milliliters. Approximately 5 ml of 0.1*N* NaOH were then added to the ether extract and the mixture distilled in vacuum until less than 1 ml of solution remained. At this point the ether-free distillate contained all the methylindole.

The quantity present was determined colorimetrically with Ehrlich's reagent, using 6-methylindole as standard. The distillate assayed 10.2 mg methylindole (assuming that it was 6-methylindole). Picric acid (100 mg) was added to the distillate and the picrate that formed was collected by filtration; 83 percent of the methylindole was recovered as the picrate. The picrate melted (melting points are uncorrected) at 156 to 160°C. The melting point of the picrate of an authentic sample of 6-methylindole was 159 to 161°C. The melting point of a mixture of the two picrates was 158 to 160°C. Reported melting points for the 4- and 6-methylindole picrates are 194 to 195° (*7*) and 157°C (*8*), respectively. The infrared spectra of the isolated material and authentic 6-methylindole picrate were determined by H. Wasserman of Yale University. Comparison of the spectra indicated that the two samples were identical. Since the isolated material is 6-methylindole, ring formation must occur through the 1-position of the benzene ring of 4-methylanthranilic acid (*9*).

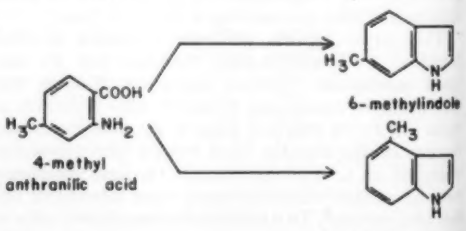

Fig. 1. The two methylindoles that would be produced depending upon whether the pyrrole ring is formed through the 1- or the 3-position of the benzene ring of 4-methylanthranilic acid.

During the conversion of anthranilic acid to indole, therefore, it seems probable that the pyrrole ring is also formed through the 1-position of the benzene ring.

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Paper Electrophoresis of Steroid Derivatives

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The preparation of pharmaceutical mixtures of estrogens, androgens, and progesterone in various concentrations and ratios has become a common practice. Owing to the lack of specificity of the available chemical and biological tests for the individual steroids in mixtures, there was a need for a technique that could be used in the identification of these compounds. A number of excellent publications have appeared on the use of partition and adsorption chromatography for the separation of the steroids, which may be used in conjunction with the technique described here. These papers have been referred to by Lieberman (*1*) and summarized by Block (*2*).

The steroids are insoluble in aqueous buffers and do not possess any appreciable charge; thus they do not lend themselves readily to a paper electrophoretic separation. Paul and Durrum (*3*) attempted to overcome the solubility problem by using nonaqueous solvents instead of an aqueous buffer. In spite of the low conductivity of such a system, they did find that the steroids moved toward the anode but failed to separate under the conditions employed. Voigt and Beckmann (*4*) esterified the steroids with succinic anhydride and were able to move dehydroandrosterone acetate, desoxycorticosterone, and dehydroisoandrosterone and to separate the last two by paper electrophoresis. Only desoxycorticosterone moved as one band, indicating that more than one product had formed during esterification. These authors also used their technique in a study of the neutral ketonic fraction in urine (*5*). They formed the hydrazones of the ketosteroids with Girard's reagent T (trimethylacethydrazide ammonium chloride) and then esterified this fraction. They do not mention any attempt to separate the hydrazones that would eliminate the esterification process.

In the present study, the hydrazones were prepared by refluxing 2.5 mg of the steroid with 7.0 mg of Girard's reagent in 2 ml of 10-percent acetic acid in methanol for 2 hr in a manner similar to that described by Zaffaroni (*6*). The paper electrophoresis apparatus and the technique of applying the samples to the paper were the same as those that I used in a study of serum lipoproteins (*7*). Several solvent systems were investigated, and the most useful one consisted of a 0.05*M* solution of sodium borate. The hydrazones were detected by viewing the completely dried electropherogram under a quartz-mercury lamp followed by dipping the papers into a solution of the Kraut-Dragondorff reagent (*2*).

The degree of separation obtained for a mixture of progesterone, testosterone, and estrone is shown Fig. 1. The excess Girard reagent has moved off the paper into the cathodic compartment ahead of the larger hydrazone molecules. The dihydrazone of progesterone that possesses two positively charged quaternary groups moves ahead of the monohydrazones that possess only one quaternary group. The monohydrazones of testosterone and estrone move at the same rate in either an acetate buffer at a *p*H of 4.5 or a diethylbarbiturate buffer at a *p*H of 8.6, but the hydrazone of estrone is less mobile than the hydrazone of testo-

Fig. 1. The electropherogram on the left shows the hydrazones of progesterone (*A*), testosterone (*B*), and estrone (*C*). The electropherogram on the right shows the hydrazones of progesterone and testosterone. The progesterone being the most mobile has moved the greatest distance from the line of application (pencil line on the electropherogram). These electropherograms were run in 0.05*M* sodium borate for 18 hr at a potential of 200 v and a current of 1.5 ma/in. width of paper.

Table 1. Relative mobilities of steroid hydrazones expressed as a fraction of the distance moved by the progesterone derivative using a conducting medium of 0.05*M* sodium borate.

Steroid	Relative mobility
Progesterone	1.00
Androsterone	0.85
Desoxycorticosterone	.83
Methyltestosterone	.77
Ethisterone	.76
Testosterone	.75
Estrone	.53

sterone in the borate system. Dissociation of the hydroxyl group at C_3 of estrone in the borate system probably results in the net charge becoming less positive than that of the testosterone hydrazone, resulting in a slower movement toward the cathode.

The relative mobilities of several steroid hydrazones are recorded in Table 1. There does not appear to be any simple correlation of relative mobilities and charge per unit of weight.

Cortisone acetate was not run in the borate system, but it moves just behind testosterone in a diethylbarbiturate buffer made up in 20-percent methanol (*7*). Hydrocortisone moved as two spots in the borate system with mobilities similar to progesterone and testosterone, suggesting that both di- and monohydrazones were present.

A dihydrazone possessing a greater ratio of net charge per unit of weight is more mobile in an electric field than a monohydrazone. The dihydrazone is more soluble in the stationary aqueous phase on a paper chromatogram and less mobile in a system, such as butanol saturated with water, than a monohydrazone. A combination of these two techniques to give a two-dimensional pattern is a more definite means of identifying steroids in pharmaceutical preparations than either of the two techniques employed alone.

The paper electrophoretic technique is considered superior to partition chromatography for mixtures where one component is present in a much higher concentration than the other components, and also for solutions containing salts or other compounds that effect the partition coefficient. The technique described has been used to separate mixtures of other quaternary nitrogen compounds, such as morphine, codeine, and choline.

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8 October 1954.

Flowering Hormone in Relation to Blooming in Sweetpotatoes

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The Jersey varieties of sweetpotato bloom sparsely if at all under ordinary conditions in the continental United States. This handicaps the sweetpotato breeder. Many investigators (*1*) have tried to induce these varieties of sweetpotatoes to bloom but none of them have been successful. However, Cordner and Sorensen (*2*) reported inducing sweetpotatoes to bloom by growing them in gravel culture and Culbertson (*3*) induced blooming by grafting. Recently Kehr, Ting, and Miller (*4*) and Zobel and Hanna (*5*) reported success in inducing flowering of Jersey varieties by grafting them on *Ipomea carnea* and *I. purpurea*, respectively. This result has been attributed to the accumulation of carbohydrates in the sweetpotato scion when it is supported by a root system incapable of forming storage roots.

The purposes of our study were (i) to develop a technique for inducing flowering in Jersey varieties and (ii) to determine the factors that induce flowering in the grafted scions of sweetpotatoes. This study was initiated in September 1953. The cleft graft has been used and the success of the grafts has varied with the different species used as grafted stocks and scions. Briefly our technique has consisted of the following steps:

1) A strong terminal of a sweetpotato shoot about ½ to 1 in. long was cut slantingly on both sides as grafted scion.

2) The stem of the stock was split longitudinally downward about ¼ in. for insertion of the scion.

3) The graft was tightly tied with a sisal fiber until the union was established. The grafted plants were kept in a humid atmosphere in a propagating box for 4 to 10 days, depending on seasonal conditions. The plants were then removed and transplanted to 6-in. pots and kept under favorable growing conditions.

A number of tests have been conducted and four of these are reported in this paper.

Effect of root-stock species. Fourteen related species forming nonstorage roots were used as stocks. A breeding line sweetpotato (P-47) was also used. Orlis (a sport of Yellow Jersey) was used as grafted scion and 5 to 10 plants of each species were grafted. The results of this test (Table 1) suggest that the absence of storage roots in the understock per se will not assure blooming in the sweetpotato scion. All but one of the 15 species used in these grafting tests are of the nonstorage root type. Only two species, *I. tricolor* and *I. hederacea*, were found to be effective in inducing flowering. It seems that various stock species have different abilities to induce blooming.

Effect of defoliation of morning glory stock. Orlis scions were grafted on the morning glory stocks (*I. tricolor*) with varying number of leaves, that is, none, 3, and 7 or more. Five to ten grafts were made in each

group. Fruit set on the morning glory stocks was prevented by removal of flower buds. In this test the flower buds appeared on the sweetpotato scion about 30 days after grafting and the first blooms appeared in about 60 days. Flowering was usually initiated at the seventh node of the scion and continued for 3 to 20 nodes, depending on the number and the continued vigor of the leaves on the morning glory stock. As the leaves of the morning glory stock became yellow with age and dropped off the scion of the nonflowering sweetpotato reverted to the vegetative phase and remained so indefinitely. The number of flowers that appeared on the Orlis scions varied directly with the number of active leaves on the morning glory stocks. No flower buds appeared on the grafted scions in the absence of leaves on the stock.

Fruits developing on stock inhibited flowering of scion. The Orlis variety was again used as grafted scion. Fourteen grafts were made and divided into two groups. Fruit set was allowed on the morning glory stock in the first group while in the other fruit set was prevented. Flowering of the sweetpotato scion was greatly favored by the defloration of the morning glory stocks since an average of 46 opened flowers per scion resulted. When fruit set was permitted on the stock, the scions bloomed sparsely (average 5 blooms per scion). It appeared that the growing fruits monopolized the flowering hormone provided by the foliage of the stock to the extent that flowering in the scion was retarded or inhibited entirely.

Flowering response of different sweetpotato varieties when grafted on I. tricolor. The Orlis, Nemagold and P-114 sweetpotatoes, varieties most difficult to induce to bloom, were used as grafted scions. The morning glory stocks were uniform with reference to the number of leaves and total absence of fruit set.

The results (Table 2) show that many more flower buds appeared on scions or Orlis and Nemagold than on those of P-114.

Table 1. Flowering response of Orlis sweetpotato scions as affected by grafting on different related species.

Grafting stock used	Date of grafting	Flowering condition of stock species*	Flowering response in Orlis scion
A. (Nonstorage root)			
I. repens	Oct.	moderate	none
I. tricolor	Oct., Nov.	many	many
I. hederacea	Oct., Mar.	many	many
I. Nil	Mar.	many	none
Quamoclit pennata	Oct., Mar.	many	none
Calyonction aculeatum	Mar.	few	none
Other species (total of 8)†	Mar.	none	none
B. (Storage root)			
I. batatas (P-47)	Oct.	many	none

* Extent of flowering in normal (ungrafted) plants grown as control.

† Plant Introduction Nos. 20916, 209127, 209130, 207818, 207821, 207822, 207823, 209319.

Table 2. Flowering response of scions of three varieties when grafted on *I. tricolor.*

Variety	No. of grafted plants	Node on which the first flower appeared	No. of flowering nodes per scion	No. of flowers per scion
Orlis	10	7 to 13	23	46
Nemagold	5	8 to 13	19	38
P-114	5	8 to 13	12	7

Conclusions. In these experiments there is no indication of direct relationship between flower bud initiation and the accumulation of carbohydrates in the grafted sweetpotato scion. In the terminal shoot ½ to 1 in. in length used as scion, about 6 to 8 nodes are differentiated. The appearance of the first flower bud at the seventh node (or first node differentiated after grafting) indicates a very rapid flowering response in the sweetpotato scion following grafting. The rapid initiation of flowering in the scion, the association of flowers on the scion with the leaves on the stock, the influence of growing fruit on the stock, all point toward the conclusion that a flowering hormone (florigen) originating in the leaves of the morning glory stock is translocated to the meristematic region of the sweetpotato scion where it exerts its morphogenetic effect.

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The Binding Energy of Ammonia in the Calcium and Barium Chloride Ammines

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The problem of the bonding between ammonia and metallic cations has been of interest for many years. Biltz (*1*) has correlated the stability of this bonding with the physical and chemical properties of the metal salts. Recently, Katzin and Ferraro (*2*) introduced a method by which it is possible to calculate the binding energies of molecular ligands to various metallic cations. Most of their work was concerned with the hydrates and pyridinates of cobalt (II) salts with

Table 1. Binding energies of ammonia in the calcium and barium chloride ammines.

Salt	Density (5)	ΔH (kcal/mole)	U (kcal/mole)	E (kcal)	Transition
$CaCl_2$	2.1741§		513.6*		
$Ca(NH_3)Cl_2$	1.8049	17.0	443.9†	86.7	Mono → anhydrous
$Ca(NH_3)_2Cl_2$	1.6060	15.0	413.5	45.4	Di → mono
$Ca(NH_3)_4Cl_2$	1.3816	10.1	370.4	53.1	Tetra → di
$Ca(NH_3)_8Cl_2$	1.1877	9.8	320.6	59.6	Octa → tetra
$BaCl_2$	3.8888		408.5‡		
$Ba(NH_3)_8Cl_2$	1.5260	9.0 (6)	318.4†	99.1	Octa → anhydrous

* Assume a rutile lattice.
† Assume a fluorite lattice.
‡ Assume a layer lattice.
§ Density of solid at 25° relative to water at 4°C.

some preliminary results on the hexammines of the alkaline earth halides. The total binding energy of the ammonia ligands was calculated for these salts and was found to be of the order of magnitude of 145–180 kcal. The problem that presents itself is to see how the binding energy of ammonia to the metallic cation changes from the lower ammines to the ammines of greater magnitude.

If one knows the lattice energies for the anhydrous salt and the ammine complex and the energy for the transition between them, it is possible to calculate the energy with which the ammonia forming the difference between them is bound. From the crystal type, the lattice energy U can be calculated by use of the equation

$$U = 279.0(\rho/M)^{1/3}A_d\left(1 - \frac{0.345}{R}\right),$$

where A_d is the appropriate Madelung constant, ρ is the density of the solid, M is the formula weight of the substance, and R is the ion-distance parameter (in angstroms). For purposes of calculation,

$$R = 10^8/(3 \times 6.023 \times 10^{23}\rho/M)^{1/3}.$$

The binding energy E is the energy necessary to dissociate the ammonia molecules from the gaseous amminated cation, the end products also being in the gaseous state. It can be expressed as

$$(b - a)E = (U_a - U_b) + (b - a)\Delta H,$$

where ΔH is the heat of formation of the ammine calculated from the Nernst equation (*3, 4*). The calculated binding energies for the ammines of calcium and barium chlorides are shown in Table 1.

The results in this table show the same trends as the work on the pyridinates of cobalt (II) salts (*2*). In the calcium chloride ammines, it can be seen that the ammonia in the transition from mono-ammine to anhydrous has a binding energy of twice the magnitude of the di-ammine to mono-ammine transition. Then as ammonia is added, the binding energy decreases considerably, falling off to 59.6 kcal for the transition, octa-ammine to tetra-ammine. Since barium chloride forms only an octa-ammine, only one transition, the octa-ammine to anhydrous, is possible, and it has a much smaller value than the similar transition in the calcium chloride system.

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Transparent Light Baffle for Electrophysiological Recording

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One difficulty encountered by investigators who are dependent on photographic records of electric phenomena is the reflection of light from the face of the cathode-ray tube. Shielding from direct and ambient light can become a cumbersome and expensive task.

This problem can be mitigated when Eastman Kodak Linagraph paper or film is used for recording from the face of a P7 cathode-ray tube (orange-blue fluorescing). Since Linagraph paper and film are both insensitive to red light, a light baffle constructed of transparent red Plexiglas may be used. A baffle of this type permits continuous observation of the cathode-ray tube while a photographic record is being obtained from the same tube. It is possible to focus the electron beam with the baffle in place. This item has proved satisfactory in shielding the light of a 75-w bulb reflected directly onto the tube face from a distance of 2 ft (Fig. 1).

A shield of this type has been constructed in our laboratory as follows: ⅛-in. transparent red Plexiglas sheet (catalog number 2444, Rohm & Haas or equivalent) was used to construct a box open at each end and a truncated pyramid open at each end (Fig. 2). The opening in the box was made large enough to receive the small shield around the face of the

Fig. 1. Demonstration of light shield: 75-w bulb at 2-ft distance, shining directly onto oscilloscope face, with (left) and without (right) red baffle in place. Without the baffle in place the image is obscured by the over-all exposure of the recording film, resulting in a completely black record.

cathode-ray tube, and yet not large enough to interfere with any of the controls on the front panel of the scope. The small opening of the pyramid was made just large enough to receive the lens of the camera. The base of the pyramid was made just large enough to telescope into the box. By telescoping in this manner the entire assembly may be removed or set in place with ease. During use the small aperture rests on the camera lens, and the large aperture rests on the shield encircling the tube face.

A horizontal rod may be used to support the baffle in place. Set screws may be used in place of the horizontal rod. We used one of the scrap triangles left over from cutting the sides of the pyramid fastened at right angles to the upper surface of the pyramid to prevent the baffle from telescoping after it had been set in place. Slots may be made for the insertion of data cards to be photographed from the face of the cathode-ray tube.

If a P11 (blue fluorescing) tube is used, the baffle should be made of blue Plexiglas, since the red filter will not transmit blue light and, therefore, does not permit continuous visual monitoring of the oscilloscope during the experiment.

Blue filters do not shield the effects of direct illumination of the screen as well as red plastic; however, the blue baffle has proved adequate to shield the film from the effects of indirect light.

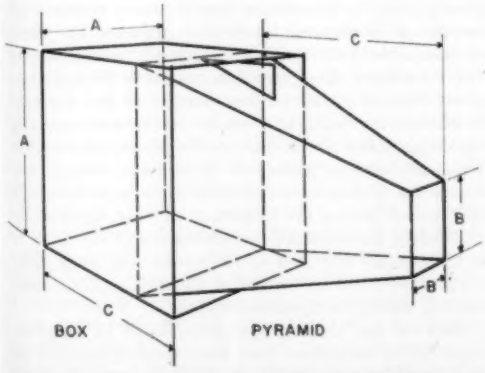

Fig. 2. Diagram of transparent light baffle. Dimensions: *A*, outside diameter of oscilloscope bezel; *B*, outside diameter of lens mount; *C*, approximately ⅝ lens to oscilloscope distance.

In summary, a plastic light baffle is here described for use with an oscilloscope that permits continuous observation of the cathode-ray tube while a photographic record is being obtained from the face of the same cathode-ray tube. This baffle shields the tube face and film from both direct and ambient light.

30 September 1954.

Conversion of 3-Hydroxykynurenine to 4,8-Dihydroxyquinoline by Mouse Liver Homogenate

Katashi Makino and Kiyohisa Arai

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When incubated with mouse liver homogenate, 3-hydroxykynurenine was degraded in various ways. Paper chromatographic analysis of the reaction mixture revealed the presence of several diazo-positive substances, two of which were identified as xanthurenic acid and 4,8-dihydroxyquinoline, respectively.

Recently Makino and Takahashi (*1*), in this laboratory, detected 4,6-dihydroxyquinoline and 4,6-dihydroxyquinoline-2-carboxylic acid in the incubation mixture of 5-hydroxykynurenine with liver homogenate of mice. The present finding (*2*) may be considered to be analogous to that of Makino and Takahashi.

3-Hydroxykynurenine, synthesized by the method of Sakan (*3*) *et al.* with a slight modification was incubated with mouse liver homogenate in Krebs-Ringer-phosphate buffer of *p*H 7.4 at 37°C. After 3 hr the reaction mixture formed a dark red pigment, which on a paper chromatogram moved very little from the starting line. The substances that were produced from 3-hydroxykynurenine by the incubation with liver homogenate were investigated by paper chromatography (solvent: butanol, acetic acid, water, 4:1:5). After 3 hr of incubation there appeared, under ultraviolet irradiation, four fluorescent substances at Rf values of 0.61, 0.48, 0.41, 0.32, respectively, and three spots (Rf = 0.45, 0.32, 0.12) detectable with diazo-reagent. A dark green fluorescent spot showing Rf 0.32 and positive diazoreaction was the residual 3-hydroxykynurenine. Other fluorescent spots and a diazo-positive spot having Rf 0.12 are now under investigation.

After 4 hr of incubation, 3-hydroxykynurenine and the fluorescent spot at Rf 0.41 disappeared, but on testing with the diazo-reagent, two other faster moving spots (Rf = 0.79, 0.64) were found. The spot at Rf 0.64 gave a brown-red color with diazo-reagent, while the one at Rf 0.79, which gave with ultraviolet light a greenish-blue fluorescence when present in sufficient amount, showed an orange-red color with the diazo-reagent. The behavior of the latter was the same as that of 4,8-dihydroxyquinoline. The diazo-positive spot at Rf 0.45 turned spontaneously green in color

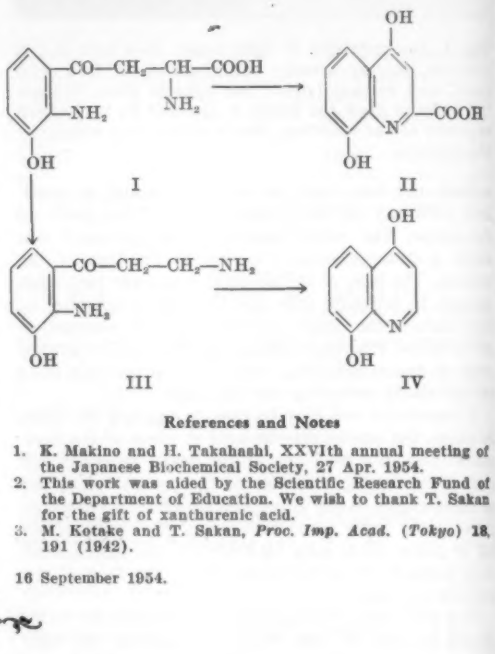
Table 1.

Sample \ Solvent	1	2	3	4	5	6	7	8
Substance A	0.79	0.79	0.04	0.69	0.64	0.09	0.68	0.75
4,8-Dihydroxyquinoline	.79	.78	.04	.68	.64	.09	.60	.77
Substance B	.45	.72	.00	.19	.05	.00	.15	.55
Xanthurenic acid	.45	.74	.00	.18	.05	.00	.15	.54

Solvent systems: (1) butanol, acetic acid, water (4:1:5); (2) methanol, butanol, benzene, water (4:2:2:2); (3) butanol saturated with 1-percent NH_4OH; (4) butanol saturated with 0.2-percent acetic acid; (5) iso-amyl alcohol saturated with 1-percent acetic acid; (6) iso-amyl alcohol saturated with 0.5-percent NH_4OH; (7) ethyl acetate, acetic acid water (5:1:5); (8) 2-percent acetic acid, isopropanol (3:7).

on exposure to the air and gave a vivid pink color with diazo-reagent. This behavior was the same as that of xanthurenic acid. So the two spots at Rf 0.79 (substance A) and Rf 0.45 (substance B) were more precisely identified by paper chromatography using seven other solvent systems, as indicated in Table 1, thus demonstrating complete coincidence of their Rf values with those of 4,8-dihydroxyquinoline and xanthurenic acid, respectively.

Since the incubation of xanthurenic acid (II) with mouse liver homogenate never led to the formation of 4,8-dihydroxyquinoline, the production of the latter from 3-hydroxykynurenine (I) may be considered to go by way of 3-hydroxykynurenamine (III), the oxidation of which seems to lead to 4,8-dihydroxyquinoline (IV), as follows.



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16 September 1954.

Communications

On the Intranuclear Environment

The success that has attended metabolic studies of mitochondria has naturally heightened desires in many cell physiologists to accomplish as much in the field of nuclear metabolism. Yet, in spite of all the studies of nuclear enzymatic composition, the results have been unimpressive. There is available a short list of the enzymes that have been classified as "nuclear," but, with one exception (a pyrophosphorylase), these enzymes are found in the cytoplasm as well. Hopes that nuclei, like mitochondria, would show a complement of uniquely localized enzymes, and thereby reveal directly the metabolic pattern of chromosome function, have remained unfulfilled. Some students of the problem, because of these results, have favored the conclusion that the interphase nucleus is the seat of few enzymatic catalyses. Other attitudes of mind have resisted the negative interpretation; occasionally a single enzyme has been chosen, and attempts have been made to wring out a special physiological significance from its presence in the nucleus. Alkaline phosphatase and adenosinetriphosphatase have been so used, but no workable perspectives of nuclear metabolism have resulted from such treatments. The most coherent—and probably the most fruitful—speculations on a pattern of nuclear metabolism have come, not from studies of nuclear enzymatic composition, but from studies of enucleation as interpreted by Brachet (*1*). In his scheme the nucleus is believed to exercise a direct and immediate influence on ribonucleic acid synthesis and phosphate esterification. Yet, the scheme skips, and does not solve, the question of an internal metabolic organization of the nucleus. To be sure, the results of present cytochemical research cannot provide a mechanism for the biochemical activities of the nucleus postulated by Brachet; but, if one avoids the objectives—borrowed from mitochondrial studies—of finding *the* important nuclear enzymes or of deciding the arithmetic contributions of the nucleus to the enzyme activities of the whole cell, some light can be thrown on the nature of the metabolic environment in which chromosomes operate.

Data on the intracellular distribution of enzymes point to the conclusion that chromosomes function in an anaerobic environment. It was first definitely demonstrated by Hogeboom *et al.* (*2*) that cytochrome oxidase is entirely absent from nuclei, a fact that has been shown to hold for a number of tissues. Thus, it

is reasonably certain that the particulate system responsible for the bulk of terminal oxidation is absent from nuclei. Flavoproteins, which may constitute either an autonomous aerobic pathway or a link in the aerobic chain between the pyridine nucleotides and the cytochromes, are also absent (*3, 4*). The latter situation is of special interest since flavoproteins, unlike cytochrome oxidase, are present not only in mitochondria but also in other structural elements of the cytoplasm. From the standpoint of cell organization (*2*), these coherent cytoplasmic elements offer a parallel with the corehent nuclear elements—the interphase chromosomes—but if the presence of nucleoproteins in each constitutes a point of similarity, the presence of flavoproteins in the one constitutes a marked point of difference. This is further underlined by the fact that cytochrome C, which is partly found in the soluble phase of the cytoplasm, presumably in contact with the more solid framework, cannot be detected in nuclei (*4*). Thus, while a potential chain for hydrogen transfer exists in the cytoplasm from the reduced pyridine nucleotides of the soluble phase, via the flavoprotein cytochrome C reductases of the coherent phase, through mobile cytochrome C to the cytochrome oxidase of the mitochondria, the reduced coenzymes of the nucleus must rely on other means for hydrogen transfer. This difference must be of importance since the respective capacities of nucleoplasm and cytoplasm to effect a primary breakdown of carbohydrate via triosephosphate or phosphogluconate are similar in concentration (*5*). Relative nuclear size is of little or no account in this matter, and in cells with large nucleo-cytoplasmic ratios (thymus, wheat germ), where the total production of reduced coenzyme from such primary carbohydrate oxidation may equal that of the cytoplasm, the absence of identifiable pathways for aerobic coenzyme reoxidation in the nucleus is given particular emphasis.

Support for the idea that chromosomes are adapted to metabolize in an anaerobic environment comes also from other sources. Nuclear division is a case in point, since, in the course of it, the chromosomes become exposed in the environment of the cytoplasm, albeit in a state more condensed than during interphase. Rapkine (*6*) had early pioneered to show that an increase in the concentration of reduced thiol groups was a precondition to cell division, thus offering the pointer that special conditions of hydrogen transfer might prevail during cell multiplication. Later, in studies of the anthers of *Lilium* and *Trillium*, where the relatively slow rate of division of the germinal tissue provides a material of choice for following sequential physiological changes, it was possible to demonstrate a relationship between the disappearance of the nuclear membrane and the appearance of a temporary phase of anaerobiosis (*7*). With present knowledge of mitochondrial function in terminal oxidation, the situation is understandable in light of the early observations of Lewis (*8*) that mitochondria become quiescent during nuclear division. The reciprocal of the foregoing relationship—that phases of nuclear division can proceed in the absence of oxygen—is also demonstrable. In depriving a growing mammalian tissue of oxygen, no effect is noted on cells that have already entered into mitosis (*9*). In polychaete eggs, inhibition of oxidation has no effect on the intranuclear formation of the ribonucleic acid and polysaccharide necessary for spindle development; under such anaerobic conditions nuclear division proceeds, but, by contrast, cytoplasmic division does not (*10*). The studies of Brachet (*11*) on nucleated and enucleated halves of amebas may also be cited: Under aerobic conditions both types maintain their ATP level equally well, but in the absence of oxygen the nucleated halves alone succeed, again suggesting that nuclear metabolism in the absence of oxygen proceeds without difficulty.

Assuming that the data is correctly interpreted, the question that obviously follows, "Why must chromosomes metabolize anaerobically?," is not easy to answer. One might suppose that, during the evolution of cell organization, oxidative mechanisms were available to nuclei as they were to other subcellular structures, and that the exclusion of oxidative mechanisms from nuclei conferred some evolutionary advantage on the genetic complex of the cell. The nature of this hypothetical advantage may be found in the somewhat opposite requirements for survival of genotype and phenotype, respectively. Survival of the phenotype is an aggressive process in which its capacity maximally to convert food to utilizable energy forms like adenosinetriphosphate (ATP) is of premium value in the course of growth; in this process terminal oxidation is a decided advantage. Given, however, the dynamic metabolic qualities of the host cell, the persistence of the genotype—however stable it might already be in consequence of its molecular organization—would appear to be better assured in a nucleus where volatile terminal oxidations are lacking and where carbohydrate breakdown, occurring at a more readily reversible level, subjects the genome to much less metabolic stress. In this connection, the finding of Conger and Fairchild (*12*) that oxygen causes chromosome breakage is of interest. ATP stores may be a secondary factor since the mediation of genetic influences depends to a large extent on the utilization of carbon chains (notably, the pentoses) that are more efficiently acquired at the expense of a limited carbohydrate metabolism of available hexoses than by CO_2 fixation at the expense of ATP. This is not to suggest that a reciprocity of substrate exchanges fails to take place between the nucleus and cytoplasm; it is meant to suggest that a measure of autonomy must be attached to the metabolism of the nucleus and that within the framework of this autonomy the operation of an anaerobic system is best suited to the metabolic requirements of the chromosomes. Along this line cytochemical studies have yielded promising information.

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20 December 1954.

Proximal or Distal Mercurial Inhibition of Succinic Dehydrogenase in the Kidney Tubules of Rat

In a recent histochemical paper (*1*) we reported that the administration of mercurophylline to rats resulted in an inhibition of the succinic dehydrogenase of the kidney, which was most pronounced in the thick ascending portions of Henle's loops. Later, Wachstein and Meisel (*2*) and Rennels and Ruskin (*3*) localized the inhibition of succinic dehydrogenase by mercuhydrin, another mercurial diuretic, in the proximal convoluted tubules. Wachstein and Meisel also stated that the ascending portions of Henle's loops retained their full activity. The highly divergent results prompted us to reinvestigate this question using both Novurit (*4*) (mercurophylline) and Mercuhydrin Sodium (*5*) as diuretics.

Blue tetrazolium (BT) and neotetrazolium (NT) were employed as histochemical indicators for the enzyme. The incubation mixtures were prepared according to Seligman and Rutenburg (*6*).

Mercurophylline in subcutaneous doses of 15 to 30 mg of Hg/kg of weight caused, within 24 hr, an almost complete inhibition of succinic dehydrogenase in the thick portions of Henle's loops, thus confirming our earlier results. This was seen both in BT- and NT-preparations (Fig. 1). The activity of the proximal convoluted tubules, especially of their straight terminal portions, was also clearly reduced. The distal convoluted tubules retained a little more of their activity.

In contrast, the administration of mercuhydrin in the same doses resulted in a very pronounced inhibition of succinic dehydrogenase in the proximal convoluted tubules, whereas the activity in the distal convoluted tubules, and especially in the thick portions of Henle's loops, was only slightly reduced, if at all (Fig. 1). These observations are in essential agreement with the results of previous investigators (*2*, *3*).

Fig. 1. BT-preparations on the left, NT-preparations on the right. Top, controls; middle, inhibition pattern by mercurophylline, 15 mg of Hg/kg of weight; bottom, inhibition pattern by mercuhydrin, 15 mg of Hg/kg of weight. Section thickness, 40μ.

Both of these diuretics contain the same amounts of mercury and theophylline. Therefore, the different organic components of these mercurials seem to be responsible for the difference in the enzymatic inhibition, probably by modifying their mode of excretion.

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8 November 1954.

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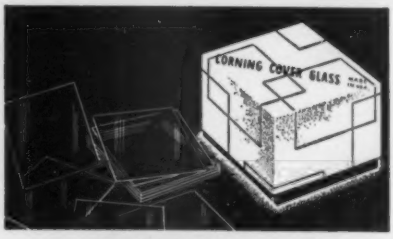

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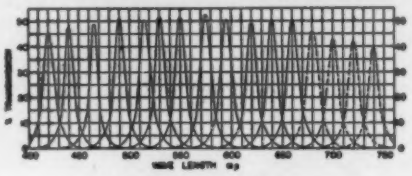

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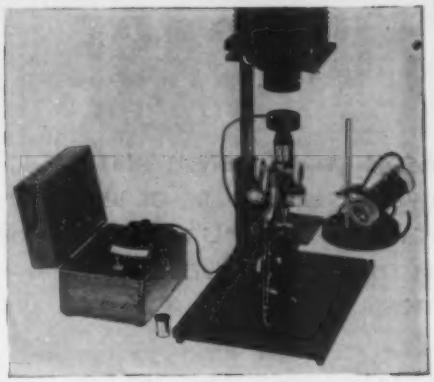

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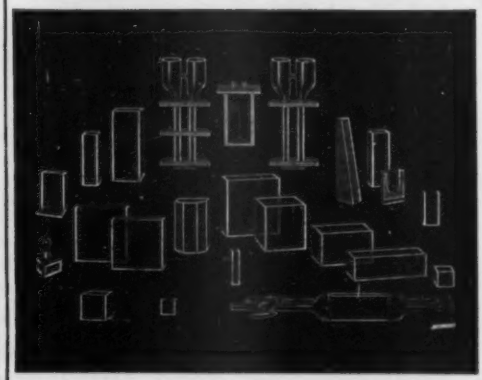

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Resignation of the Editor

ON 15 October I asked the board of directors of the Association to be relieved of the editorship of *Science* and *The Scientific Monthly* as soon as a suitable successor could be found. Circumstances unforeseen at the time have made it desirable for me to terminate now, even though a permanent editor has not been appointed. On 1 February I am joining the technical staff of the Ramo-Wooldridge Corporation, Los Angeles. Dr. Dael Wolfle, the administrative secretary of the Association, has assumed charge of the periodicals, at least temporarily.

I accepted the editorship on 1 December 1953 on short notice and with a considerable adjustment in my plans, at a time when the two periodicals lacked both a full-time editor and a full-time assistant editor. I agreed to come in the belief that help was seriously needed and with the hope that there would be freedom and facilities to develop the periodicals along lines that eventually would serve to make them the most useful to readers in a day that nearly everyone will agree is far different from that of even a few years ago.

My surmise that help was sorely needed turned out to be correct. Moreover, there was gradual acquiescence to my insistence that facilities be expanded to permit the initiation of certain improvements as well as to continue others that had been envisaged by the board of directors and board of editors. For instance, the number of text pages in *Science* has been markedly increased, to 2037 pages in 1954. As a result, it has been possible to increase the variety of material published in each issue and to expand materially the sections devoted to news and notes, meeting reports, and book reviews. There has been prompter publication of certain kinds of material, especially communications, news, and listings of new books and miscellaneous publications. Attempts have been made to obtain and publish more lead articles of broad appeal. A number of minor changes in style that serve to reduce processing and printing costs have been made. Lately we have been trying to give each paper a preliminary editing at the time of revision or acceptance; authors then have an opportunity to answer queries and pass judgment on suggested changes before the paper is set in type, thus often reducing the number of alterations that otherwise would have to be made on galley proof.

But much more must be done if *Science* is to become a "news weekly" in the present-day sense of the term. *Science* is not the place for highly specialized technical papers or lead articles of the archive type. Instead, it should be primarily a medium for the very prompt publication of important new advances, brief surveys and reviews of progress in fundamental fields, articles and discussions pertaining to current issues vital to scientists and the sciences, copious news and notes, including brief digests of important articles appearing in other journals, and so on. All this should be couched in the broad language of the sciences but not in the jargon of the highly specialized field of research.

Moreover, in my opinion, it should no longer be considered an accomplishment, as has been the case in some earlier years, to be able to operate the periodicals on a skimpy budget so as to provide additional funds for other Association activities and facilities. Indeed, a next step for the immediate improvement of the periodicals would be to curtail some of the activities that are now taking money away from them. Then, as revenues from subscriptions and advertising gradually increased, as they surely would with improved periodicals, the more worth-while extraperiodical activities could be resumed and probably even broadened. The potential circulation of a modern news weekly for all scientists is tremendous. Doubtless some members of the Association would look with disfavor on attempts to change radically the character of *Science*, and this is understandable. But the alternative might well be that *Science* will succumb to competition. This would be a pity in view of the price that the AAAS had to pay to acquire ownership of *Science* and the many years of effort that a succession of editors have spent in keeping it going. The comment has been made that a commercial concern rather than the AAAS might have more of the "know how" for putting out a suitable weekly for scientists. What it actually would have is the freedom to assemble the staff and facilities needed to do the job.
—D.R.

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2–4. American Assoc. of University Professors, Gatlinburg, Tenn. (R. E. Himstead, AAUP, 1785 Massachusetts Ave., NW, Washington 6, D.C.)

7–9. Chemical Inst. of Canada, Divisional Conf. of the Chemical Engineering Div., Ottawa, Ont. (W. M. Campbell, Box 323, Deep River, Ont.)

7–11. American Soc. of Photogrammetry, Washington, D.C. (C. E. Palmer, 1000 11 St., NW, Washington 1.)

7–11. National Assoc. of Corrosion Engineers, 11th annual, Chicago, Ill. (A. B. Campbell, 1061 M & M Bldg., Houston 2, Tex.)

8. Soc. for Applied Spectroscopy, New York, N.Y. (G. L. Crumrine, North American Smelting Co., Marine Terminal, Wilmington, Del.)

9–11. American Cong. on Surveying and Mapping, 15th annual, Washington, D.C. (W. S. Dix, Room 435, Woodward Building, Washington 5.)

10–12. M. D. Anderson Symposium on Fundamental Cancer Research, Houston, Tex. (Univ. of Texas, M. D. Anderson Hospital and Tumor Institute, Houston.)

14. American Educational Research Assoc., Denver, Colo. (F. W. Hubbard, 1201 16 St., NW, Washington 6, D.C.)

14. Wildlife Soc., Montreal, Canada. (D. L. Leedy, Fish and Wildlife Service, Washington 25, D.C.)

15. Philadelphia Sec., Soc. for Applied Spectroscopy, Philadelphia, Pa. (G. L. Crumrine, North American Smelting Co., Marine Terminal, Wilmington, Del.)

15–17. Electrical Utilization of Aluminum, American Inst. of Electrical Engineers, Pittsburgh, Pa. (N. S. Hibshem, AIEE, 33 W. 39th St., New York 18.)

17–19. American Physical Soc., Baltimore, Md. (K. K. Darrow, Columbia University, New York 27.)

17–19. International Symposium on Cardiovascular Surgery, Detroit, Mich. (John Keyes, Henry Ford Hospital, Detroit 2.)

17–19. National Wildlife Federation, Montreal, Canada. (C. H. Callison, 232 Carroll St., NW, Washington 12.)

17–2. Inter-American Statistical Conf., 3rd, Santiago, Chile. (IASI, Pan American Union, Washington 6.)

20–23. American Assoc. of Dental Schools, annual, Chicago, Ill. (M. W. McCrea, 42 S. Greene St., Baltimore 1, Md.)

21–23. Aero Medical Assoc., 26th annual, Washington, D.C. (R. J. Benford, P. O. Box 1607, Washington 13.)

24–26. National Science Teachers Assoc., Cincinnati, Ohio. (R. H. Carleton, 1201 16 St., NW, Washington, D.C.)

25–26. Michigan Acad. of Science, Arts and Letters, E. Lansing, Mich. (George M. McEwen, Univ. of Mich., Ann Arbor.)

28–31. American Assoc. of Petroleum Geologists, New York, N.Y. (E. H. Powers, Box 670, Fort Worth, Tex.)

28–1. Western Metal Exposition, 9th, Los Angeles, Calif. (W. H. Eisenman, 7301 Euclid Ave., Cleveland 3, Ohio.)

31–2. Soc. of Research in Child Development Monticello, Ill. (C. B. Stendler, College of Education, Univ. of Illinois, Urbana.)

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1–5. Japan Medical Cong., Kyoto. (M. Goto, Univ. Hospital, Kyoto Univ., Kyoto.)

(See issue of 21 January for more comprehensive listings.)

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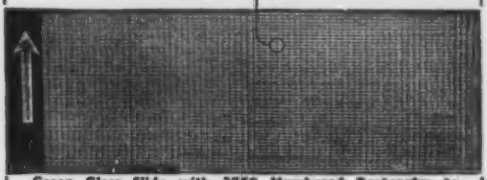

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